ANNUAL REPORT 2015-16

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ICAR-National Institute of Animal Nutrition and Physiology
Bengaluru

वार्षिक प्रतिवेदन

Annual Report
2015-16

भाकृअनुप–राष्ट्रीय पशु पोषण एवं शरीर क्रिया विज्ञान संस्थान
बेंगलूरु

ICAR-National Institute of Animal Nutrition and Physiology
Bengaluru

Citation

ICAR-NIANP Annual Report 2015-2016

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Cover page theme

The graphic depicts the Institute's research endeavour in understanding the basic and fundamental aspects of animal nutrition and physiology and factors influencing them

Design and layout

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Preface

Indian agriculture experienced a paradigm shift during mid-1960's through the realization of Green Revolution. However, the necessity to produce more agricultural products has become more intense with the ever growing population of the country. Currently, the major challenge of the agricultural scientists, policy makers and administrators is to produce sufficient agricultural products for over 1.3 billion population of the country. The other impending factors that will substantially contribute to the hurdle are the changing climatic scenario and incriminating influences of anthropogenic origin due to rapid urbanization. Therefore, systematic planning and out of the box research efforts and technology developments are the need of the hour to produce sufficient agricultural produce from the gradually shrinking natural resources.

Livestock farming has remained as an integral component of Indian culture and livelihood. It plays a pivotal role in the rural economy. Livestock offers economic shield and livelihood security to several hundred thousands of poor and landless Indian farmers. I strongly believe that this sector is yet to experience a true revolution in terms of organized and technology intensive farming and the days are not distant. Unlike agriculture sector, the influences of external factors are easier to handle in case of the livestock farming. However, ensuring quality feeds for different livestock production targets will be the major challenge in this regards. Simultaneously, precise understanding of the various physiological, cellular and molecular functions/processes that govern the animal system will be required to introduce customized animal production system for efficient conversion of feeds to foods.

During the last 20 years, ICAR-NIANP is relentlessly working in understanding the various basic and fundamental aspects of animal nutrition and physiology. The institute's primary focus is to improve production and reproductive efficiency of different livestock species through basic physiological and nutritional approaches and interventions. During the XII plan period, the institute has directed its research endeavours under six well conceptualized research programmes: Deconstruction of lignocellulosic biomass for improving feed utilization; Understanding biogeography of animal gut microbes; Developing novel approaches for assessing and improving nutrient availability, animal production and reproduction; Developing feed informatics and ensuring feed quality, safety and value addition; Assessing climate change impact on livestock; Making efforts towards technology translation to connect discovery with application.

The ICAR-NIANP team is extremely thankful to the Council for receiving overwhelming supports in terms of resources, guidance and various other facilities. I sincerely thank for the constant support and guidance from Dr S Ayyappan, Secretary, DARE and Director General, ICAR. Warm thanks are due to Dr KM Bujarbaruah, Vice Chancellor, Assam Agricultural University, Jorhat and Chairman Research Advisory committee and the members of the august body for critical review and constructive suggestions in research endeavour. I gratefully acknowledge the encouragement from Prof. KML Pathak, DDG (AS). I thankfully acknowledge the support of Dr BS Prakash, ADG (AN&P), Dr Rajan Gupta, Pr. Scientist (AN) and Dr Vineet Bhasin, Pr. Scientist (APB) for their constant support and coordination at the ICAR level.

It will be unfair not to put on record the untiring effort of the scientists and other staff of the Institute. Their hard work and dedication has been duly reflected in this report. I congratulate the entire team of the Editorial board for bringing out this report as per the schedule.

It is my privilege to present you the salient achievements of the Institute in the form of annual report 2015-16 for your perusal and critical comments. The report will serve as a reference to those in the field of animal nutrition and physiology.

Raghavendra Bhatta

Executive summary

The ICAR-National Institute of Animal Nutrition and Physiology has successfully completed 20 years since inception and continued its excellence in catering the farmers, educationists, extension workers, policy makers and industries associated with livestock farming. During the financial year 2015-16, the Institute functioned with 40 scientists, 10 technical staff, 13 administrative and accounts personnel and 5 skilled supporting staff under the dynamic leadership of the Director, Dr Raghavendra Bhatta. The total plan and non-plan budget allocations were Rs 1848.00 lakh and the total expenditure was Rs 1761.49 lakhs during the financial year. The institute generated Rs 52.2 lakh as revenue during the period. The scientists of the Institute relentlessly worked for achieving various targets related to research and technology demonstration, defined under the six major programme as per the mandate.

Deconstruction of ligno-cellulosic biomass for improving feed utilization

In India, ruminants are traditionally fed on crop residues containing high amount of lignocellulosic complexes with poor digestibility. The programme is aimed at improving the digestibility of such poor quality crop residues through advanced technological research. The Institute has taken up the programme in flagship mode during the XII plan period.

White rot fungi are known for their ability to produce lignin degrading enzymes. A total of 35 commercial strains were screened for production of lignin peroxidases (LiP) and Mn peroxidases. The fungi were selected for enhanced enzyme production using immobilization on PUF cubes. The purified LiP produced through immobilization showed wide pH tolerance and exhibited higher stability to the one obtained in submerged culture and is expected to survive changes in pH encountered in the gut. The enzymes were tested on various crop residues for their quality improving effect. The studies demonstrated improved digestibility of lignocellulosic materials.

Biogeography of gut microbes in animals

The microbial presence in the compartments of the digestive system have been identified as an important constituent of the animal body and are responsible for nutrition, immunity and other physiological functions. Knowledge of the microbial communities in the gut would help in revealing the unexplored potential to improve the animal production system, amelioration of methane emissions from ruminants and bioprospecting newer genes for industrial application.

The rumen microbial diversity was probed with terminal restriction length polymorphism technique. The terminal restriction fragments generated form the amplified phylogenetic marker gene (16S rRNA) were resolved and microbial species identification was done in cattle, buffalo, sheep and goat samples. The principal component analysis revealed differences in the microbial diversity among these species indicating unique composition for the ruminal microbiome.

Cattle rumen microbial clone library was generated to study the bacterial diversity. Bacterial species belonging to the genus Prevotella (33%) was observed as the most abundant in cattle rumen followed by genus Bacteroides (28%), Streptococcus (11%) and Clostridium (10%). Whole metagenomic profile was also generated to study the microbial population and carbohydrate active enzyme in cross bred steers. The studies revealed Glycoside Hydrolases (GHs) were the most abundant in cattle rumen metagenome. Glycosyl transferases were the second most abundant carbohydrate active enzyme family followed by carbohydrate binding modules and carbohydrate esterases.

The 16S rRNA gene sequence information has been used as the “gold standard” for identification and taxonomic classification of bacterial species. Analysis and comparison of the bacterial 16S rRNA sequence is a valuable genetic technique and can lead to the recognition of novel species. Characterization of the ruminant microbiome will require 16S rRNA database for rumen specific microbes for wide and comparative analysis of microbes within and between ruminant species.

Currently, there is no such rumen specific database available with web tools for analysis of 16S rRNA sequences. In an effort to build a database, sequences from existing repositories are being identified and pooled in structured databases and web tools are being developed.

The rumen microbe culture collection is a part of ICAR's initiative on developing Veterinary Type Culture Collection. At ICAR-NIANP, microbes isolated from rumen environment of various livestock species are accessioned, characterized and maintained for future use. Different strains of fibre degrading bacterial species of *Butyrivibrio hungatei, Butyrivibrio proteoclasticus, Prevotella ruminicola and Prevotella enoca* were isolated from cattle rumen and preserved. Twenty seven cultures of bacteria and four isolates of anaerobic fungi were deposited into the repository during the period of 2015-16.

Methane emission from rumen ensure the safe disposal of excess hydrogen, which otherwise would accumulate and will be fatal for the animal system. In recent years with advancement of research, other hydrogenotrophic microbes having good capability for H_2 utilization is also reported. One category of such hydrogenotrophs is reductive acetogens that are capable of utilizing H_2 as a basal substrate for reducing CO_2 into methane. Presence of the acetogens in sheep rumen was established and different type of acetogens were identified based on the molecular signatures of the microbes. The acetogens were found to colonize in Indian sheep as early as 10 days of age.

Novel approaches for assessing and improving nutrient bioavailability, animal reproduction and productivity

For improving bio-availability of nutrients for different production processes and augmenting the reproductive efficiency in livestock, investigations were carried out under various projects. Strategic nutrient supplements to provide limiting nutrients were formulated for precise feeding of nutrients in order to enhance milk production performance in cattle. Precision feeding with strategic nutrient supplements reduced CP intake up to 12%, increased FCM yield up to 16% and increased overall daily income of the farmers up to Rs 50/animal in medium yielding dairy cows.

Boron is less studied element in the animal nutrition. To establish the role of boron in calcium homeostasis, effect of boron supplementation was studied on calcium absorption, serum biochemicals, immunity response and overall growth. Boron supplementation improved calcium utilisation, immunity and growth performance, but did not affect tissue architecture of visceral organs.

Nanominerals are expected to be superior to the inorganic and organic mineral supplements in animal diet. To establish the effect of nano zinc supplementation in wistar male rats, different levels of nano zinc oxide (ZnO) preparation were supplemented and effect on various parameters was recorded. ZnO nanoparticles supplementation significantly improved sperm motility and humoral immunity.

Dietary Selenium (Se) is essential for growth, immunity and reproduction and is an important factor in determining optimal health and disease susceptibility of sheep. The effect of dietary selenium on antioxidant status, immune status, meat quality and expression of selenoprotein genes in sheep was studied. A positive trend in antioxidant and immune status was observed in sheep supplemented with organic selenium.

Neonatal supplementation of amino acids and trace minerals was studied on developmental patterns of gastrointestinal and immune system in poultry. The amino acids supplementation into 18d embryonated eggs indicated significant improvement in body weight gain. Supplementation of amino acids may be beneficial during the perinatal phase of broiler chicken. However, *in ovo* injection of Nano Zn at the rate of 80μg/egg did not alter the growth performance, gut development and immunity of broiler chicks.

The dietary level of copper affects the expression profiles of copper-related transporters and chaperone genes in sheep. To identify copper deficiency using biomarkers by comparing the differential expression status of selected copper transporter and chaperone genes in sheep,

transcriptomic profile was generated and validated by qPCR. The differentially expressed transcripts were further analysed to understand the pathways affected in the upstream and down streams due to the changes in expression of these genes. Dietary levels of copper affected the expression profiles of copper-related transporters and chaperone genes in whole blood, RBC and liver tissues in sheep.

Trace mineral supplementation has been found to be associated with rapid testicular growth, changes in LH secretory pattern, a gradual increase in blood testosterone, initiation of spermatogenesis and improvement of semen quality and fertility in goats. It was observed that organic zinc and copper had a positive role in growth of testicular biometry and expression of sexual behaviour. Sexual behaviour varied among the experimental groups and it was found to be higher in mineral supplemented groups.

The widespread use of pesticides in agricultural practices and ectoparasiticides in livestock and other environmental pollutants such as heavy metals are directly or through soil, water and feeds, lead to the presence of these residues in edible products of animal origin (milk, meat and eggs). These issues are very important to consumers and international trade, which relates to public health. To address these issues, it is required to monitor environmental pollutants in soil, water, feeds, fodders and animal products. The presence of Arsenic, Lead and Cadmium was also detected in hair samples.

Three agricultural wastes namely cotton, tobacco and bajra stalks were used for xylan extraction and enzymatic production of prebiotic xylo-oligosaccharides (XOS). The XOS has potential applications in improving gut health in animals. The XOS produced form bajra stalks were evaluated against gut pathogens in broiler chicks. No significant effect was noticed on body weight gain, feed conversion efficiency, blood lipid profile due to XOS supplementation. Further, challenging with established poultry pathogens was unable to bring out visible adverse affects on litter, but sporadic diarrhoea was noticed in few birds. No significant difference was noticed as a result of administering XOS in experimentally challenged birds.

Efficacy studies on laboratory produced and commercial phytase enzyme were conducted in layer chicken. The results indicated that the egg production, feed intake, egg weight, FCR and shell quality was not significantly different for the first 8wk of experimental feeding. However, a drop in egg production, feed intake and FCR in the next 4wk of experimental feeding was observed in the group supplemented with lab phytase and replacing complete source of inorganic phosphorus in diet. The partially purified fungal phytase at the level of 250FTU/kg could replace 50% of inorganic phosphorus in diet.

The All India Coordinated Research Project (AICRP) was initiated in 2014-15 with 12 centres throughout the country, led by ICAR-NIANP to assess the extent of infertility conditions and possible interventions through nutritional and physiological means in animals. The data collected from 1126 animals revealed that 21% of the animals had reproductive problems and among the reproductively problematic animals, 57% were repeat breeders. 54% of the repeat breeders had luteal insufficiency and among the postpartum anoestrus animals, 19% showed silent oestrus. To improve the semen quality, IGF1 at the level of 150ng/ml was found to significantly improve post-thaw viability and acrosome intactness and protected sperm function during cryopreservation process by protecting sperm membrane proteins. The higher proportion of immune regulatory protein in low fertile bulls and differential expression of these proteins between the bulls differing in fertility were established. It was also revealed that cfs-mRNA can be used to predict sperm susceptibility to cryoinjury.

Failure of ovulation is one of the major causes of reproductive failures and infertility in domestic ruminants. Sufficient levels of estradiol are required during the proestrous and estrous periods to elicit lutenizing hormone surge that is responsible for ovulation. Possibility of using minerals to reduce the amount of hormone usage in reproductive management protocols like estrus induction and estrus synchronization was investigated. Copper and selenium either alone or in combination promoted the ovarian granulosa cell estradiol synthesis and upregulated estradiol synthesis

associated genes in goats. Both minerals stimulated Wnt signalling that enhanced estradiol synthesis through Non-canonical Wnt Signalling pathway.

Adequate light intensity is required to stimulate receptors responsible for gonadotropin releasing hormone (GnRH) release in the poultry hypothalamus, because these receptors are suggested to be sensitive to light directly passing through the skull instead of perception of light by eyes. Embryonated eggs were exposed to different wavelength of light to establish their effect on post hatch performance. Continuous *in ovo* stimulation with green light accelerated the early body weight gain with concomitant increase in pectoral muscle weight at 35d post hatch.

To understand the differential functional biology of sheep oocytes and 2-cell embryos of different development ability, transcriptome analysis was performed to reveal the differences between the competent and less competent sheep oocytes and embryos. A marked difference in the cellular and biological functions between the oocytes and 2-cell embryos of good and poor development competence was evident. Based on the results of transcriptome data, important cellular processes were identified which hold promise for manipulation to stimulate *in vitro* oocyte and embryo development in sheep. The findings will go a long way to design strategies for providing artificial competence to oocytes for enhancing their fertilizing ability and post-fertilization development *in vitro*.

NEFA and ß-OHB concentrations can be used as a tool with other factors to diagnose problems during the metabolic stress in sheep. Metabolic stressors caused oocyte and preantral follicle impairment by inducing apoptosis, lipid peroxidation and oxidative DNA damage. Large preantral follicles are more susceptible to the metabolic stressors compared to the small ones. The increased ammonia caused maximum impairment to preantral follicle growth compared to other stressors. Oocyte morphology, its fertilizing capacity and granulosa cell functions in ewes (obese, normal, metabolic stressed and emaciated) were assessed. Body condition and feeding status of the animals influenced the oocyte morphology and fertilizing capacity.

The relative stage specific expression level of different apoptotic and antioxidant enzyme genes in different stages of developing embryos as well as L-Carnitine mediated alteration in expression pattern of these genes in different stages of developing embryos was studied. The relative expression levels of apoptotic and antioxidant enzyme genes were found stage specific. L-Carnitine treatment during maturation significantly upregulated the expression of Bcl2, GPx and PCNA genes, downregulated the expression of Bax and SOD2 genes, whereas the expression pattern of SOD1, Casp3 and GAPDH genes were unaffected in oocytes and embryos.

Semen cryopreservation is an indispensable tool to preserve and propagate elite germplasm for breeding and improvement of farm animal species. However, the post-thaw motility and the associated fertility of cryopreserved sperm is found to be reduced substantially making it a major impeder of success of artificial insemination. It was observed that buffalo sperm suffers a significant degree of lipid peroxidation after a cycle of freezing and thawing. The seminal plasma of buffalo semen differed significantly in terms of metabolite composition as compared to that of cattle.

The conventional tests such as sperm progressive forward motility, sperm concentration and abnormalities to evaluate semen quality are not accurate predictors of bull fertility. Thus, there remains a need for molecular approaches for determining fertility in males. Twelve bulls were selected for RNA-Sequencing based on the field conception rate and functional parameters. The analysis of sperm transcriptome revealed the presence of 4500 to 5000 moderately abundant transcripts in bovine sperm that might regulate sperm function. The results suggest that spermatozoal transcripts can be used to understand the past events associated with spermatogenesis and its possible functional role in fertilization and embryo development.

The spermatogonial stem cells (SSCs) are unique testicular cells having the ability to regenerate their own pool of cells and alternatively differentiate into functional spermatozoa. The SSCs provide an ideal model to understand the molecular mechanism

involved in spermatogenesis, regulation of male fertility and also to improve male fertility by transplantation of superior quality SSCs. Efforts were made for isolation and identification of SSCs from sheep testicular tissue. The enzymes collagenase and trypsin were found most suitable for SSCs isolation from prepubertal ram testis. SSCs identification in testis and cell isolate was confirmed by SSC marker PLZF.

Early diagnosis of pregnancy is important for better managemental practice in buffaloes. Nevertheless, no buffalo specific pregnancy detection kit is available currently. The majorly expressed transcript (PAG) in early buffalo cotyledon were identified and recombinantly produced. Anti-sera raised against the recombinant buffalo PAG is being used to develop buffalo PAG specific immuno-assay (EIA/RIA) using purified antigen and antibodies.

Changing climate affect the livestock production. To understand the effect of heat stress and simultaneous nutritional stress in goats, studies were designed and impact of feed restriction on growth, stress, metabolic hormone, haematological and blood biochemical responses, and hepatic gene expression was studied. The nutritional stress affected somatotrophic axis function. Simultaneous occurrence of two stressors had greater impact on biological functions necessary to adapt to the stressful conditions. Plasma testosterone level could be used as a reliable indicator for studying the impact of environmental stresses. It was established that when nutrition was not compromised, goats were able to counter heat stress effectively.

Feed informatics, feed quality and safety and value addition

Real time information of animal population and feed resources is vital for development of livestock sector. ICAR-NIANP is developing information technology based tools to improve data collection and compilation, estimate feed and fodder resources availability in terms of concentrates, green and dry fodder in all the mandals/taluks of India. The database would be useful in forecasting the surplus/deficit at micro level in real time to assist the planners/administrators. A website was designed based on open source software platform for real time collection and compilation of livestock data.

Various lactic acid bacteria were evaluated for application in silage making.

Climate change impact on livestock

Heat and nutritional stresses have been found to alter the maternal uterine micro-environment and thereby affect maternal recognition of pregnancy (MRP) by modulating ovarian, luteal and endometrial function. The quality and development of sheep oocytes were found compromised in response to heat stress. Heat stress, nutritional stress and combined stress modulated the expression profile of genes regulating MRP and implantation in sheep endometrium. Supplementation of FGF2 and ITS alone or in combination in maturation media was found beneficial for sheep oocyte and embryo development.

In broiler chicken, kinetics of HSP70 was found both tissue and time dependent under hyper-thermic state. Histo-pathology study indicated immuno-suppression of birds under heat stress. Supplementation of KCl, Vit-C and $NaHCO_3$ in combination was found most effective to ameliorate stress.

Life Cycle Assessment (LCA) of GHG emission is an approach that includes all emissions along the supply chain starting from land use, production of feed, emissions from animal production and emissions related to processing and transportation of products to the end users. LCA of GHG emission from the selected dairy farms in Karnataka was conducted. Preliminary results indicated that CH_4 emission from enteric fermentation (IPCC tier II) in dairy HF cross cows was 93.7 to 100.4 g/head/d. The CH_4 emission from manure management system was found to be 1.51 to 1.56 g/head/d and nitrogen excretion was 96.7 to 116.6 g/head/d.

Methanogenesis is thought to be a necessary, but wasteful process for the animal system and its complete inhibition is neither recommended, nor possible. Therefore, the efforts are continuously being made to mitigate the enteric methane

emission to a desirable and significant extent for saving the biological energy for animal use. Supplementation of tamarind seed husk at the level of 2.5, 5.0 or 10.0% significantly reduced methane production *in vitro*. Similarly, 5% tamarind seed husk supplementation significantly reduced methane production *in vivo*. The efficacy of tannin supplementations and immunization approaches is being explored currently for effective and safe mitigation of methane. Supplementation of CT and HT at moderate levels significantly reduced methane production without altering digestibility *in vitro*. Similarly, supplementation of saponins at low level significantly reduced methane production *in vitro*. Further, supplementation of the combination of saponins, CT and HT was found most effective than individual supplementation in reducing methane production *in vitro*. A joint Indo-Japan project has also been initiated to assess the potential of phyto-sources from natural plants and food industrial byproducts to reduce enteric methane emission from ruminants. Sixteen plant samples were collected from the Himalayan region for *in vitro* analysis to explore their potential for methane reduction.

Technology translation to connect discovery with application

The institute participated in a project with the Centre of International Cooperation in Agronomic Research for Development (CIRAD), Re Union Island, France for developing effective collaboration with the other Indian Ocean rim countries (Australia, Madagascar, Mozambique, Reunion (France), South Africa and Union of Comoros) for skills exchanges on dynamic adaptation of ruminant production systems to a changing environment.

Human resource development

During the reported period, the Institute was actively involved in various human resources development activities. A total of 36 students registered under different universities used laboratory facilities of the Institute for pursing their MSc and PhD dissertations. Various trainings, workshops, meeting and technology awareness program were organized for the scientists, academicians, extension professionals, policy makers and farmers. Three-month attachment trainings were also organized for three newly recruited ARS scientists. The scientists of the Institute received professional training from various national and overseas Institutes/ organizations and attended various workshops, conferences, seminars, symposia, krishi mela and expos. The technical, administrative, accounts and supporting staff also received various professional training for skill development.

Others

The Institute in association with the ADNAT, CCMB Campus Hyderabad, organized the International Symposium on 'Microbiome in Health and Disease (MicroHD-2016)' from 23-25 February, 2016, at ICAR-NIANP, Bengaluru. The symposium provided an exceptional platform for more than 170 delegates to share, exchange and update the latest developments, opportunities, challenges in the microbiome research in various domains of biology.

The Institute also observed various official functions such as Republic Day, Independence Day, Hindi Pakhwada, Institute Foundation Day and World Environment Day. Various social events were also organized by the Staff Welfare Club for the staff and their families.

The Institute is regularly conducting activities under “Swachh Bharat Abhiyan” with the resolution to work towards realizing the Mahatma Gandhi's dream of “Swachh Bharat”. Various initiatives were taken to maintain the office and campus premises clean and environment friendly. Additionally, to extend the scientific expertise for the benefit of farmers, the Institute has implemented Mera Gaon Mera Gaurav programme. The programme includes 10 teams of 4 scientists each and every team has identified 5 villages for regular visits and providing technical inputs to the farmers.

Introduction

The ICAR-National Institute of Animal Nutrition and Physiology (ICAR-NIANP) was established in 1995 under the aegis of the Indian Council of Agricultural Research (ICAR) to conduct fundamental studies on basic nutritional and physiological problems related to bio-physical translation of nutrients for productive functions in livestock.

Location

The institute is located in the heart of sprawling Bengaluru city on the National Highway No.7 on Hosur Road. The institute is approximately 8 kms away from the Bengaluru City Railway Station and 40 kms from the Kempegowda International Airport.

Faculty

The Institute is headed by the Director and currently 40 scientists including six women scientists are in position.

Staff position as on 31-03-2016

Category	Sanctioned posts	Staff in position
Director	1	1
Scientific	40	40
Technical	12	10
Administrative and Accounts	17	13
Skilled supporting staff	6	5
Total	**76**	**69**

Priority Setting and Management

The Institute has a high powered Research Advisory Committee (RAC) comprising of eminent scientists and professor, who guide the research agenda of the institute and set research priorities. Dr KM Bujarbaruah, Vice-Chancellor, Assam Agricultural University, Jorhat is the chairman of the committee. The other members include scientists, professor and industry personnel from the field of Animal Nutrition, Physiology, Biotechnology, Reproductive Biology and Social Science.

The functioning of the institute is supervised by Institute Managemental Committee (IMC) headed by the Director of the institute as Chairman and members drawn from state government, university, and public including industry personnel. A number of internal committees such as Central Purchase, Library, Official Language Implementation, ISO 9001-2008 Implementation, Grievance, Publication, Priority Setting Monitoring and Evaluation Cell, RFD Cell, Staff Welfare Club, IPR Cell, Institute Technology Management Unit have been constituted to decentralize the management with developed responsibilities for smooth functioning of the institute. The Institute Joint Staff Council has been constituted for promoting healthy and congenial work environment. The Institute Research Council (IRC) provides a platform for effective professional interactions in respect of review and implementation of various research projects, which are also supported by an external evaluation committee. The Priority Setting, Monitoring and Evaluation Cell headed by two Principal Scientists plays a major role in prioritising the internal and external projects based on the mandate and thrust areas. Moreover it has forward and backward linkages with RAC, IRC and HYPM in project monitoring and evaluation.

In the XII plan, new thrust areas have been identified to strengthen the basic and fundamental research in niche areas and six major programmes have been identified. A new AICRP on “Nutritional and physiological approaches for enhancing reproductive performance in animal” with 12 centres has started in the XII plan. The institute is coordinating an Outreach project on methane emission in ruminants with seven collaborating centres and is a partner in the Outreach project on drug residues and environmental pollutants, ICAR-CRP project on evaluating value added cereal by products for animal feeding, and ICAR-Network project on Veterinary Type Culture Collection. Besides, the institute scientists also have been associated with two projects funded by ICAR-NASF, nine projects funded by DBT and one project funded by ICAR-Extramural fund. Translation of discovery into application through technology transfer being effectively carried out through the knowledge management and biostatistics section.

Vision

Productivity enhancement for profitable and sustainable livestock production

Mission

Improving production and reproductive efficiency in livestock through basic physiological and nutritional approaches

Mandate

The mandate of the institute is to conduct fundamental studies on basic physiological and nutritional problems related to biophysical translation of nutrients for productive functions in livestock by

- Unravelling basic physiological and nutritional principles and conducting research on fundamental aspects arising out of research in animal production in the country.
- Effectively utilizing the scientific manpower at specialized level at one place and demonstrating how nutrition and physiology principles function in practice and thereby improve rural economy through better livestock feeding and management approaches.

Objectives

To achieve the mandate of the institute the following broad objectives and programmes have been outlined:

- To carry out qunatitative and qualitative assessment of feed resources and to develop district-wise information system.
- To enhances availability of nutrients through various approaches viz., strategic supplementation, biotechnological interventions and feed processing technologies.
- To enhance reproductive efficiency of livestock through physiological and nutritional interventions.
- To address the issues of feed quality and safety.
- To develop strategies for validation of evolved technologies at user's level for production enhancement.

Institute programmes

Prog. 1 Deconstruction of ligno-cellulosic biomass for improving feed utilization (Flagship Programme 1)

Prog. 2 Biogeography of gut microbes in animals (Flagship Programme 2)

Prog. 3 Novel approaches for assessing and improving nutrient bioavailability, animal reproduction and productivity

Prog. 4 Feed informatics, feed quality and safety and value addition

Prog. 5 Climate change impact on livestock

Prog. 6 Technology translation to connect discovery with application

Expenditure statement

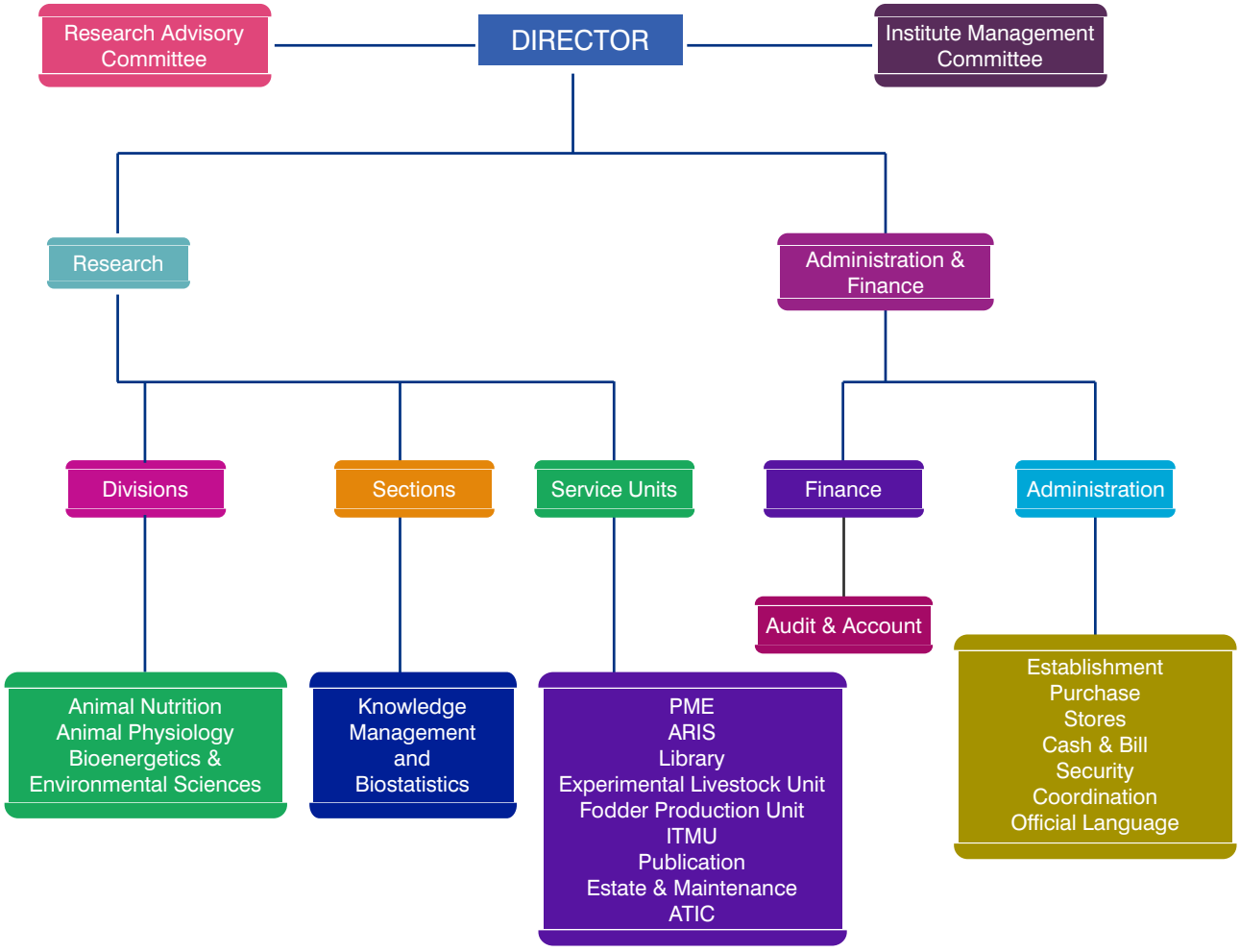
Statement showing the sub head wise expenditure under plan and non-plan budget (Rs in lakh)

Sl No.	Sub Heads	Plan 2015-16		Non Plan 2015-16		Revenue resources 2015-16	
A) Institute		RE	Expenditure	RE	Expenditure	Funds available	Funds utilized
1	Establishment charges	0.00	0.00	963.00	962.99	-	-
2	OTA	0.00	0.00	0.00	0.00	-	-
3	Travelling expenses	10.00	9.77	3.00	3.00	-	-
4	Other charges including equipments	272.45	248.24	155.00	152.10	40.00	32.28
5	HRD	4.00	3.94	0.00	0.00	-	-
6	Works	53.55	3.54	0.00	0.00	-	-
	Total (A)	340.00	265.51	1121.00	1118.10	40.00	32.28
B) AICRP and Outreach projects		387.00	377.88	0.00	0.00	0.00	0.00
Grand total (A+B)		**727.00**	**643.39**	**1121.00**	**1118.10**	**40.00**	**32.28**

Revenue generation (Rs in lakh)

Sl No.	Particulars	Amount
1	Sale from livestock, farm products etc.	2.51
2	Other receipts	
	Sale from publications	0.27
	Analytical testing fee	2.94
	Other receipts including LF/ interest/ IRGS/LS/PC	46.41
	Total	**52.18**

Organizational Setup



The matrix mode of management is adopted in the research activities which provides devolved responsibilities for effective implementation of multidisciplinary/interdisciplinary programmes. For administrative purposes, the Institute has identified three research divisions and one section with strong support of central facilities and computerized administrative set up. Director is the Head of the Institute, supported by administrative and financial wings. To strengthen the local decision-making and research monitoring, Research Advisory Committee, Institute Management Committee, Institute Research Council and PME Cell play a vital role through periodical meetings.

Research Projects

Programme 1 Deconstruction of Ligno-Cellulosic Biomass for Improving Feed Utilization

DBT Project: Biomining of selected white rot fungi (WRF) for novel lignin peroxidase and manganese peroxidase for enhancing digestibility of crop residues

S Manpal, S Senani and AK Samanta

A majority of WRF degrade lignin selectively by help of their lignin degrading enzymes laccases, lignin peroxidase and manganese peroxidase. Complete availability of the trapped energy (70%) in crop residues could be affected by the use of exogenous lignin peroxidases and manganese peroxidases. The improvement in the utilization of cellulose and hemicellulose, the energy component present in crop residues by ruminants will enhance production.

Thirty five commercial strains of WRF were screened for LiP and MnP, and these could be detected in *Phanerochaete chrysosporium*, *Phanerochaete flavidoalba, Phanerochaete magnoliae,Phellinus pini, Phlebia tremellosa 2845, Phlebia tremellosa 77-51, Phlebia brevispora, Phlebia radiata* L12-41, *Phlebia radiata* MJL-1198-Sp., *Phlebia radiata 79*, *Bjerkandera adusta, Trametes trogii, Flavodon flavus, Fomes fomentarius Funalia trogii*, *Coriolopsis gallica, Heteroporiu biennis, Trametes versicolor, Trametes hirsuta* and *Coriolus versicolor* comprising 53% of the total screened isolates. Thirty two percent of the strains secreted only MnP and were comprised of *Phlebia subserialis, Ceriporiopsis subvermispora, Dichomitus squalens, Lentinula edodes, Pleurotus ostreatus, Pleurotus sajor-caju, Rigidoporus lignosus. P. ribis, P. frivialis* and *P. torulosus* produced the highest activities while *Pleurotus eryngii* and *Cerrena unicolor* secreted comparatively low levels. *Phlebia ochraceofulva* and *Junghuhnia separabilima* secreted only LiP. Both the enzyme activities were absent in *Piptoporus betulinus, Schizophyllum commune-NI07* and *Pleurotus dryinus*. In wild isolates screened, high LiP activity was obtained in the three isolates LPS1, LPS2 and LPS3 (Table1, Fig. 1), while AUG007, AUG010 and AUM021 were most promising white rot basidiomycetes strains for MnP production. Microscopic observations showed characteristic features belonging to basidiomycetes. The isolates recording maximum activity were optimized further and immobilized on different matrices for enhanced production. PUF cubes gave the best results. LiP thus produced was subjected to ammonium sulphate fractionation and gel filtration. The purified LiP showed wide pH tolerance and exhibited higher stability to the one obtained in submerged culture and would be appropriate for feeding/oral dosing of ruminants and expected to survive changes in pH encountered in the gut.

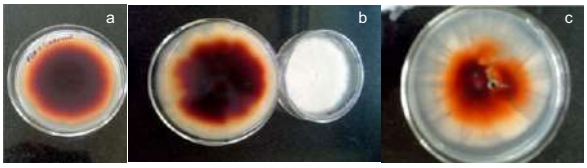


Fig. 1: The characteristic dark brown color in a few of the cultures is on account of Guaiacol. Screening for Lip: Reddish brown color formation around the colony a):LPS-01, b):LPS-02, c):LPS-03.

Table 1: Activity (Mean±SE) of crude (T1) and purified (T2) lignin peroxidases (LiP) obtained from the three wild type white rot fungi.

Enzyme	LPS1	LPS2	LPS3
T1	0.39±0.06	0.26±0.04	0.25±0.03
T2	0.68±0.12	0.54±0.11	0.49±0.13

LiP's were obtained after immobilization to enhance production (T1) and after purification (T2) and were used in the study. Straw/stover of Finger millet (FMS), little millet (LM), bajra (BA), Barnyard millet (BRM), Paddy (PS), maize (MS), jowar (JR), Foxtail millet (FXM) and prosomillet (PRM) were manually chaffed into 2 cm length and treated by spraying with LiP enzyme extracts of both T1 and T2 at an enzyme to straw ratio of 1:2.5. Untreated straw/stover served as control. Highest reduction in NDF was recorded in ragi straw (18.0%) and lowest in bajra 3.58% upon treatment with purified LiP. Little millet recorded maximum reduction in ADF (18.1%) while lowest reduction was observed in bajra (0.38%). Maximum

reduction of lignin was observed in jowar (2.87%) followed by paddy (2.66%) and bajra (2.04%). Digestibility (IVDMD) of all the straws treated with both the crude and purified enzyme showed a considerable increase as compared to the control (Table 2).

The purified LiP produced through immobilization showed wide pH tolerance and exhibited higher stability to the one obtained in submerged culture and would be appropriate for feeding/oral dosing of ruminants and is expected to survive changes in pH encountered in the gut.

Table 2: Variations (Mean±SE) in neutral detergent fibre (NDF), acid detergent fibre (ADF), acid detergent lignin (ADL) and in vitro dry matter digestibility (IVDMD) of straw/stover following the treatment with crude (T1) and purified (T2) lignin peroxidases.

Straw	Treatment	Dry matter	% DM basis			
			ADF	NDF	Lignin	IVDMD
Finger millet	C	95.8±3.14	39.1±0.36	78.1±0.61	6.98±0.06	40.0±3.65
	T1	94.1±2.99	35.0±1.04	74.1±1.34	5.90±0.14	45.5±6.01
	T2	93.8±8.76	34.1±1.62	63.1±0.22	5.72±0.07	58.2±1.06
Little millet	C	95.8±2.82	49.1±0.36	79.9±0.07	6.48±0.16	41.8±1.94
	T1	94.4±2.98	31.3±0.94	79.0±0.85	5.05±0.21	53.0±0.06
	T2	94.0±1.88	31.0±0.12	74.4±6.20	5.49±0.31	54.1±1.78
Bajra	C	96.8±3.72	46.1±0.66	80.6±0.08	6.91±0.02	44.9±3.00
	T1	95.8±2.82	45.8±1.24	77.1±0.07	6.16±0.08	58.3±2.01
	T2	95.0±3.21	45.7±1.60	77.0±0.20	4.87±0.04	64.5±4.22
Barnyard millet	C	94.0±3.03	48.8±0.75	81.5±0.01	6.90±0.09	43.8±1.13
	T1	92.1±1.94	45.3±0.25	73.7±2.67	5.80±0.14	60.7±4.96
	T2	92.8±2.19	45.1±0.28	69.1±1.56	5.49±0.42	64.6±2.08
Maize	C	96.4±2.92	49.5±0.90	80.0±0.24	6.23±0.15	42.6±3.22
	T1	95.0±1.87	47.8±0.91	75.9±3.77	6.31±0.27	58.4±4.44
	T2	94.2±2.28	40.0±1.05	73.6±0.64	5.71±0.22	62.5±3.02
Jower	C	96.4±1.92	46.6±0.11	80.6±0.64	7.00±0.44	43.9±1.56
	T1	95.5±1.77	42.1±1.00	73.6±2.19	6.73±0.18	55.4±3.17
	T2	95.0±3.20	41.5±0.38	72.0±1.04	4.13±5.85	57.2±2.01
Paddy	C	95.3±3.10	49.1±1.09	81.5±0.71	8.28±0.21	41.8±3.96
	T1	95.0±1.04	48.0±1.18	76.0±0.35	7.00±0.00	56.5±2.11
	T2	94.8±2.01	46.8±1.98	66.0±2.76	5.62±0.01	58.5±3.25
Foxtail millet	C	6.3±1.97	48.2±0.46	81.4±0.59	7.80±0.51	43.3±0.94
	T1	95.8±2.43	45.2±1.32	73.2±2.20	6.96±0.23	60.9±2.06
	T2	95.1±3.80	45.1±0.63	69.5±0.71	6.36±0.03	63.4±1.16
Proso millet	C	96.1±1.86	49.8±0.13	82.3±0.06	6.78±0.12	39.2±0.88
	T1	95.2±2.39	41.1±0.11	77.5±1.41	6.35±0.07	58.0±3.07
	T2	95.1±3.11	38.4±0.18	66.6±1.89	5.68±0.06	60.5±1.26

Programme 2 Biogeography of Gut Microbes in Animals

BGM 2.1: Molecular profiling of rumen acetogens at different developmental stages in sheep

PK Malik, A Thulasi and NM Soren

So far, reductive acetogens in India are not reported or studied. The present study aimed to establish molecular profile of rumen acetogens in sheep during different developmental stages and explore the termite hindgut acetogens diversity and comparison with acetogens in ruminants.

The study established the presence of acetogens in indigenous Indian sheep and profiled the acetogens from birth to adult stage using molecular tools. The rumen acetogen in eight *Mandya* sheep were mapped at pre-weaning (15, 30, 60 and 90d), weaning (100d) and adult (180 and 365d) stages fed on ragi straw and concentrate based diet. A simplified method for the collection of rumen content from 2-d old lambs was developed. Genomic DNA was isolated from the rumen liquor samples of lambs/adult collected at different developmental stages. Genomic DNA was amplified (Fig. 2) using *fhs* functional gene specific primers (FTHFS_F and FHTFS_R), ligated and cloned into pGEMT vector.

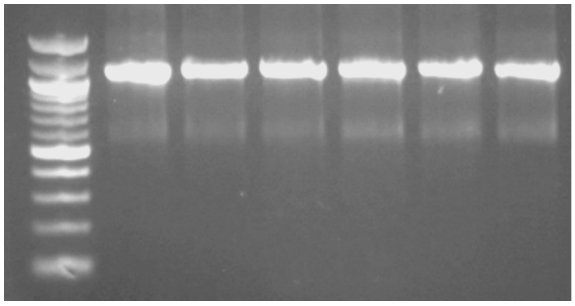


Fig. 2: PCR amplification of fhs functional gene from rumen liquor samples

Rumen acetogens in *Mandya* sheep at different developmental stages were compared and found that these microbes are very dynamic, however, few uncultured acetogens showed their presence at multiple developmental stages. Majority of the sequences on placing in phylogenic tree showed a distant relationship with known rumen acetogens. However, 30% of the sequences were grouped with known rumen acetogens. Approximately 20% of the total sequences grouped with Panda *(Ailuropoda melanoleuca)* homoacetogens, where the presence of acetogens is recently established. Eight annotated functional gene (*fhs*) sequences were submitted to the NCBI with accession no. KP294513 - KP294520. The sequences from rumen acetogens in sheep showed similarity with signature 2 of *fhs* in Prosite. These sequences fall into 4 groups based on the prosite signature sequence 2. Sequences from termite did not have any similarity with acetogen sequences from rumen. Volatile fatty acid analysis from post-weaning samples revealed no significant change in acetate, propionate, butyrate and A:P ration between the two developmental stages of 180 and 365 days.

***The presence of acetogens in Indian sheep* from 10 days onward was established.**

BGM 2.2: Comparative rumen metagenomics of domestic ruminants

AP Kolte, A Dhali, R Bhatta and AK Samanta

The knowledge of microflora involved in rumen fermentation could be useful for bioprospecting of microbes for nutrient synthesis. Although, a large proportion of diversity contains uncultured bacteria, the comparisons among the species might reveal their ecological niche and roles in rumen function. The project is expected to reveal a core microbiome, microbiome diversity for each species vis-à-vis for rumen function. Identification of differentially present microbes may reveal new information that could be useful in explaining species wise differences among livestock species.

The rumen liquor samples collected from sheep and goat were pelleted, lyophilized and stored at -20^{0}C. These samples were used for metagenomic DNA

isolation with RBBC protocol with bead beating procedure. Four metagenomic DNA samples were prepared for each species. The 16s rRNA gene amplification was performed using 27F and 972R universal primers for prokaryotic organisms. For terminal restriction length polymorphism, the 16S rRNA amplicons were generated using 5'-FAM labeled primers. TRFs were generated using MspI, AluI, HinfI and BsuRI restriction enzymes. Resultant TRFs were subjected to sizing analysis on ABI sequencer. The TRFs sizing data was generated through Gene mapper (Applied Biosystems) software. The data was filtered for fragments below the length of 30bp and filtered TRFs were calculated. The TRFs generated by different enzymes in cattle, buffalo, sheep and goat are shown in Fig 3. The metagenomic DNA samples are being sequenced for revealing the microbial diversity.

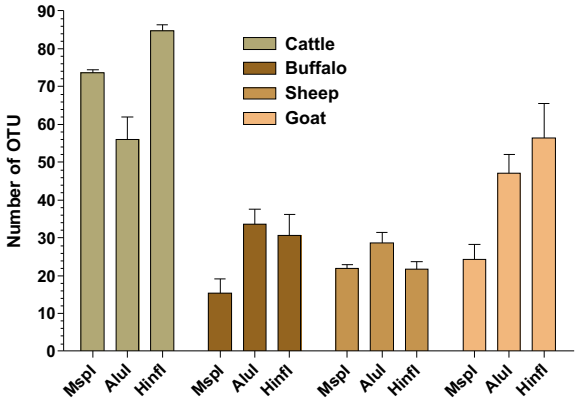


Fig. 3: Number (Mean±SE) of OTUs generated using 16s rRNA gene by MspI, AluI and HinfI enzymes in different ruminant species

The rumen microbial profiles established in Cattle, Buffalo, Sheep and Goat through TRFLP technique.

BGM 2.3: Development of 16S rDNA rumen microbes specific database

M Bagath, AP Kolte, UB Angadi and M Grover

The 16S rRNA gene sequence information has been used as the "gold standard" for identification and taxonomic classification of bacterial species. Analysis and comparison of the bacterial 16S rRNA sequence is a valuable genetic technique and can lead to the recognition of novel species. With the recent advances in molecular research and information technology, the 16S rRNA sequence data are available in diversified format and in various public databases. The 16S rRNA data is a quite large and dynamic data. Therefore, there is a need to develop 16S rRNA database for rumen specific microbes for wide and comparative analysis of microbes within and between species. Currently, there is no such rumen specific database available with web tools for analysis of 16S rRNA sequences. The project aimed to create a collection of rumen microbes' sequence (16S rRNA/DNA) from the available public database, standardise and pre-process the data and develop database. Approximately 4.7 lakh sequences were downloaded from various databases such as NCBI, MG-RAST, RDP etc. The downloaded sequence was screened and standardized by converting them into suitable data tables appropriate for database model. Further the sequence data was integrated using the rational suitable data model. All the tables were created in relational database management system (RDBMS) using MYSQL software. The database structured with various fields and database developed as per entity relationship. The website has been created and is being hosted using super computer ASHOKA from ICAR-IASRI. The web site is available at http://webtom.cabgrid.res.in/rumen_16s_rRNA.

Approximately 10000 sequences were finally obtained after screening and filtering. Website has been created and is being hosted using super computer ASHOKA.

ICAR-Network Project: Veterinary type culture collection-rumen microbes

A Thulasi, D Rajendran and M Chandrasekharaiah

The rumen microbe culture collection is a part of ICAR's initiative on developing Veterinary Type Culture Collection. At NIANP, microbes isolated from rumen environment of various livestock species are accessioned, characterized and maintained for future use. The major activities under this project are to isolate and purify anaerobic gut microbes, study

the micro-morphological and biochemical characteristics and establish molecular signatures of the purified gut microbes, accession the cultures submitted to the repository from various centres following characterization, revive the cultures periodically to check their viability and determine the microbial diversity in crossbred steers using NGS technology.

Different strains of fibre degrading bacterial species of *Butyrivibrio hungatei, Butyrivibrio proteoclasticus, Prevotella ruminicola* and *Prevotella enoca* were isolated from cattle rumen and preserved. Different bacterial strains such as *Enterococcus durans, Desulfotomaculum ruminis, Selenomonas sputigena, Lactobacillus paracasei, Actinomyces ruminicola* were also isolated and preserved in the repository. Twenty seven cultures of bacteria and four isolates of anaerobic fungi were deposited into the repository during the period of 2015-16.

Bacterial 16S clone library was constructed to study the bacterial diversity in cattle rumen fed with paragrass, straw and concentrate. The total DNA was extracted from the rumen digesta and almost full length 16S rRNA gene was amplified by using specific primers. The PCR products were purified and cloned into pGMT easy vector. A total of 138 clones were sequenced, analyzed and submitted to Genbank (KU161400 to KU161537). The 16S clone sequences were also analyzed by using SILVA data base and a Crona chart was constructed to study the bacterial community profile (Fig. 4).

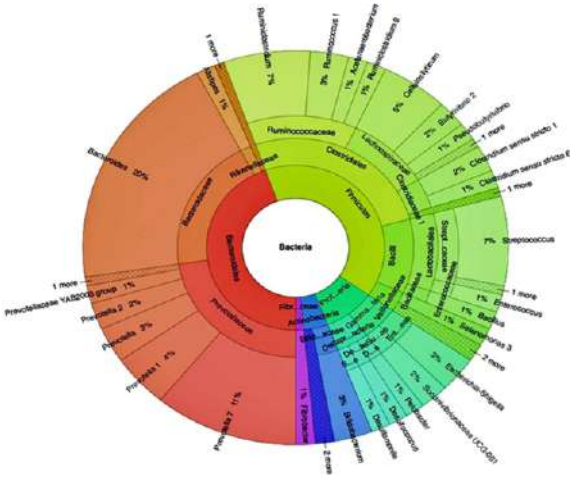


Fig. 4: Phylogenetic classification of bacterial community using SILVA Database.

Whole metagenomic analysis was carried out to study both microbial diversity as well as carbohydrate active enzyme profile in cross bred steers. The total DNA was subjected for Illumina MiSeq (2×300 PE) sequencing and the metadata was uploaded on MGRAST server. The sequences obtained after NGS were converted into open reading frames (ORFs) by using FragGeneScan program. The ORFs were then analyzed by using CAT tools on Carbohydrate Active Enzyme (CAZy) data base (Fig. 5). NGS analysis by using CAZy data base revealed that carbohydrate active enzymes belonging to the class Glycoside Hydrolases (GHs) were the most abundant in cattle rumen metagenome. Glycosyl transferases were the second most abundant carbohydrate active enzyme family followed by carbohydrate binding modules and carbohydrate esterases.

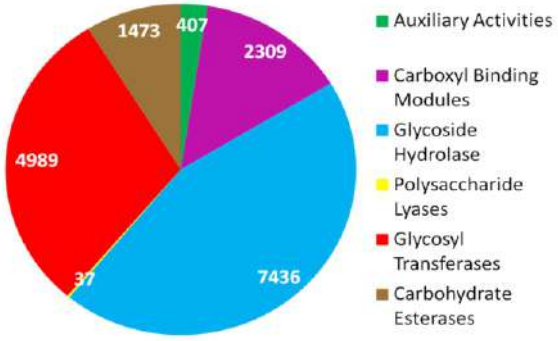


Fig. 5: CAZy enzyme distribution in cow rumen

Twenty seven cultures of bacteria and four isolates of anaerobic fungi were deposited into the repository during the period of 2015-16. Bacterial species belonging to the genus Prevotella (33%) was observed as the most abundant in cattle rumen followed by genus Bacteroides (28%), Streptococcus (11%) and Clostridium (10%).

Programme 3 Novel Approaches for Assessing and Improving Nutrient Bioavailability, Animal Reproduction and Productivity

APR 3.1: Precision feeding for enhancing milk production performance in cattle

M Chandrasekharaiah, NM Soren, SBN Rao and IJ Reddy

Strategic nutrient supplements to provide limiting nutrients were formulated for precise feeding of nutrients in order to enhance milk production performance in cattle. Studies were conducted in two phases.

In the phase-I, five strategic nutrient supplements (1, 2, 3, 4 and 5) were prepared with locally available bypass rich protein/amino acid supplements, bypass fat and area specific mineral mixture. The *in sacco* studies were carried out in crossbred steers to determine degradability of strategic nutrient supplements and bypass fat. In the phase-II, two lactation trials were conducted each with 4 months in Anagalpura and Menesi villages of Doddaballapura taluk, Bangalore district, Karnataka to study the effect of feeding strategic nutrient supplements on the milk production performance in crossbred cows. In the 1st lactation trial, 36 crossbred cows were selected and divided into six comparable groups (control and experimental) of six animals in each based on lactation number, milk yield and stage of lactation. 1st group served as control as practiced by the farmers, 2, 3, 4, 5 and 6th groups were fed with supplements 2, 3, 4 and 5 respectively. In both the villages, the cows in control group were fed local mixed grass with supplements such as GNC and wheat bran as practiced by the farmers. Animals in experimental groups were fed local mixed grass with GNC, wheat bran and supplements 1, 2, 3, 4 or 5 at the rate of 200g/day/animal by replacing the double the quantity of GNC in the control group. The results indicated that feeding with strategic nutrient supplements reduced CP intake by 1.5 to 8.2%, increased FCM yield from 2 to 16%, reduced feed cost by of Rs 2 to 7 and increased overall income of the farmers by Rs 15 to 50/animal/day in medium yielding cows fed on grass based diets. Subsequently three best supplements were selected. The 2nd lactation trial was conducted on straw based diets. Twenty eight crossbred cattle were divided into 4 groups of 7 animals in each. The cows in control group were fed Finger millet straw (FMS) with supplements such as GNC and wheat bran as practiced by the farmers. Animals in Experimental groups were fed FMS with GNC, wheat bran and supplements (best supplements selected from 1st lactation trial) 1, 2 or 3 at the rate of 200g/day/animal by replacing the double the quantity of GNC in the control group. The results indicated that, precision feeding with strategic nutrient supplements, reduced CP intake by 8 to 12% without compromising the microbial protein synthesis, increased FCM yield from 9 to 16%, reduced feed cost by Rs 4 to 9 and increased overall income of the farmers by Rs 24 to 38/animal/day in medium yielding cows fed on FMS based diets.

Precision feeding with strategic nutrient supplements reduced CP intake up to 12%, increased FCM yield up to 16% and increased overall daily income of the farmers up to Rs. 50/animal in medium yielding dairy cows.

APR 3.2: Amelioration of oxidative stress to prevent apoptosis of early sheep embryos

A Mishra, PSP Gupta and V Sejian

The relative stage specific expression level of different apoptotic and antioxidant enzyme genes in different stages of developing embryos as well as L-Carnitine mediated alteration in expression pattern of these genes in different stages of developing embryos was studied (Fig. 6). The relative expression level of Bcl2 was found significantly

(p<0.05) downregulated in morula, whereas maximum upregulated expression was found in *in vitro* matured oocytes. Significantly (p<0.05) higher upregulation of Bax was observed at morula and least expression was observed at 2-4 cells stage. Highest (p<0.05) upregulated expression of Casp3 was observed at 8-16cells and least expression was observed in *in vitro* matured oocytes. Significantly (p<0.05) upregulated expression of PCNA was found in blastocyst and downregulated expression was found at morula. From antioxidant enzyme genes studied, significantly (p<0.05) upregulated expression of GPx in *in vitro* matured oocytes and downregulated expression in zygote were observed. Highest upregulated expression of SOD1 was found in 8-16 cells. Relative expression of SOD2 was significantly (p<0.05) low among all the antioxidant enzymes studied in this experiment. Highest upregulated expression of SOD2 (p<0.05) was observed in immature oocytes and significant (p<0.05) downregulation was observed at 8-16 cells. L-Carnitine treatment during maturation significantly (p<0.05) upregulated the expression of Bcl2, GPx and PCNA genes and downregulated the expression of Bax and SOD2 genes in oocytes and embryos. The expression pattern of SOD1, Casp3 and GAPDH genes were unaffected by L-Carnitine treatment.

In subsequent experiment, the oocytes matured with L-Carnitine showed significantly (p<0.05) higher cleavage, morula and blastocysts percentage as compare to presumptive zygotes cultured with L-Carnitine during post fertilization period concluded that it is better to use L-Carnitine during maturation period than culturing embryos during post fertilization period. L-Carnitine was further proved as proliferative compound by culturing embryos with TNFα with or without L-Carnitine respectively. Embryos (2-4 cells) exposed to TNFα showed developmental arrest and could not reach upto blastocyst but embryos (2-4 cells) exposed to TNFα with L-Carnitine showed further development to blastocysts as that of control group proving L-Carnitine as a proliferative compound. Anti-oxidant effect of ergotheoneine was proved by culturing oocytes and embryos with H_2O_2 with or without Ergotheoneine. Ergotheoneine was able to neutralize the oxidant effect of H_2O_2 in culture medium to show subsequent embryo development.

The relative expression levels of apoptotic and antioxidant enzyme genes were stage specific. L-Carnitine treatment during maturation significantly upregulated the expression of Bcl2, GPx and PCNA genes, downregulated the expression of Bax and SOD2genes, whereas the expression pattern of SOD1, Casp3 and GAPDH genes were unaffected in oocytes and embryos.

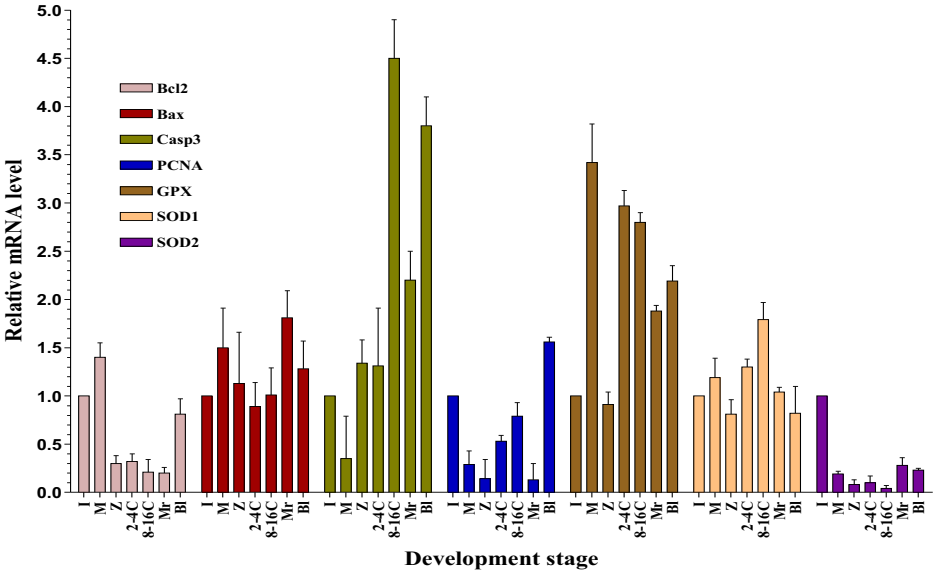


Fig. 6: Quantitative expression of apoptotic and antioxidant enzyme genes at different developmental stages in sheep embryos. I: immature oocytes, M: matured oocytes, Z: zygote, 2-4C: 2-4 cells, 8-16C: 8-16 cells, Mr: morula, Bl: blastocysts.

APR 3.3: Elucidating the endocrine and molecular mechanisms of feed restriction impacting somatotrophic axis in goats

V Sejian, A Mech, NM Soren, CG David, SBN Rao and M Bagath

The project aimed to investigate impact of feed restriction on growth, stress, metabolic hormone, haematological and blood biochemical responses, and hepatic gene expression in goat. The hypothesis of the study was that the arid environment adapted species that are subjected to nutitional change to mimic the one similar to that expected across a season may suffer severely and it is possible to identify physiological and genetic markers that are applicable for welfare assessments. Two experiments were conducted in Osmanabadi goats to prove this hypothesis. The first experiment was conducted to establish purely the nutritional stress effect on somatotrophic axis related gene expression and endocrine profiles in goats and the second experiment was conducted to establish the effect of nutritional status in relieving heat stress impact in Osmanabadi goats.

In the first experiment, the significantly higher plasma growth hormone (GH) and lower body weight, plasma IGF-1 and leptin level in goats in nutritional stress group as compared to control group demonstrated the severity of nutritional stress in the study. This study also established the effect of nutritional stress on GH expression in the pituitary and growth hormone receptor (GHR) gene expression in the liver. The nutritional stress induced in this study caused changes at cellular level of somatotrophic axis, suggesting that plasma levels of IGF-1 and leptin may act as blood biochemical markers for nutritional stress in goats, even in arid-adpated breeds. The results also revealed that respiration rate (RR), rectal temperature (RT), T3, T4 and cortisol are considered as nutritional stress markers for goat. The study also revealed HSP70 and HSP90 as a suitable biological marker for nutritional stress alone in goats.

In the second experiment, attempt was made to establish the impact of two stresses (heat and nutritional) simultaneously on adaptive capability, growth, reproductive performance, and rumen fermentation pattern in goat. The behavioural responses showed significant variations between the groups (Fig. 7) indicating that the animals depended hugely on these mechanisms to cope up to environmental stress condition. The highest plasma cortisol, GH, aldosterone and HSP70 levels were recorded in CS group (Fig. 8). In contrast, highest plasma testosterone, T3 T4 and leptin levels were recorded in C group (Fig. 8). The highest plasma HSP70 level was recorded in CS group. The impact of different stressors on toll-like receptor (TLR) gene expression was also assessed during the current study (Fig. 9). The significantly higher TLR1, TLR3, TLR6, TLR7, TLR8 and TLR10 mRNA expression in HS groups indicated that when nutrition was not compromised heat stressed animals were able to maintain their immune functions against heat shock proteins. This suggested that supplementing additional nutrition during heat stress periods may be highly beneficial for maintaining the immune status in the goat.

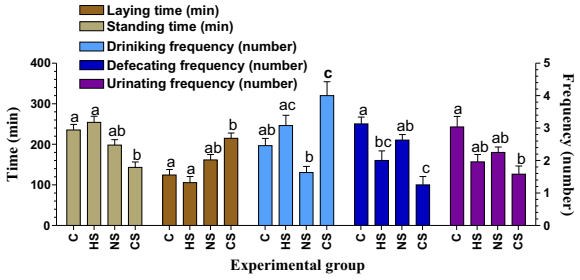


Fig. 7: Effect (Mean±SE) of heat stress (HS), nutritional stress (NS) and combined stresses (heat and nutritional, CS) on the behavioural responses in goat. C: control; a,b,c indicates p<0.05.

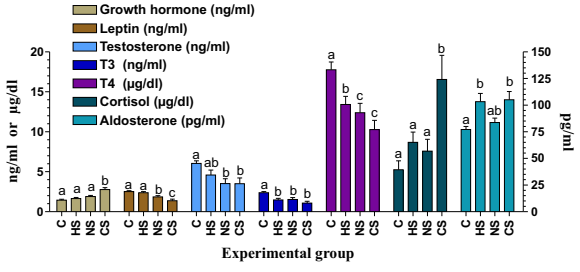


Fig. 8: Effect (Mean±SE) of heat stress (HS), nutritional stress (NS) and combined stresses (heat and nutritional, CS) on the endocrine responses in goat. C: control; a,b,c indicates p<0.05.

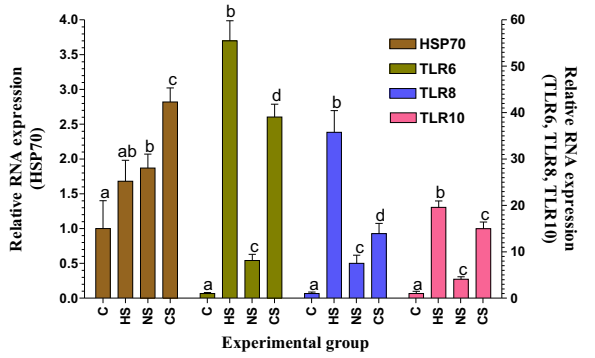


Fig. 9: Effect (Mean±SE) of heat stress (HS), nutritional stress (NS) and combined stresses (heat and nutritional, CS) on different gene expression in goats. C: control; a,b,c indicates p<0.05.

In conclusion, simultaneous occurrence of two stressors had greater impact on biological functions necessary to adapt to the stressful conditions. Plasma testosterone level could be used as a reliable indicator for studying the impact of environmental stresses on buck. Further, the study indicated that lying time, drinking frequency, RR, RT, plasma HSP70 and peripheral blood mononuclear cells (PBMC) and adrenal HSP70 gene expression are ideal biological markers for assessing the impact of CS on adaptive capabilities in bucks. It was established that when nutrition is not a limiting factor, bucks were able to better cope up with heat stress by maintaining their growth and reproductive performance.

The impact of nutritional stress on goat could be established through the assessment of somatotrophic axis related physiological and genetic markers. It was established that when nutrition was not compromised, goats were able to counter heat stress effectively.

APR 3.4: Elucidating role of boron on gene expression for calcium utilisation, immune response and anti-oxidant mechanism

NKS Gowda, DT Pal, S Mondal and P Krishnamoorthy

Feeding trial was carried out in 24 sheep assigned to 2×2 factorial design, with two levels each of boron (B; 0 or 40ppm) and calcium (Ca; 100 or 50% of requirements). The results of 180d feeding trial indicated that dietary B had no influence on the nutrient digestibility. The balance of Ca, P, and Mg was improved ($p<0.05$) with B, while N balance remained unaltered. The intake of DM and CP were higher in lambs fed Ca-deficient diets. However ADG (g/d) improved in B-supplemented groups. The serum levels of triglycerides, ALP and AST were decreased ($p<0.05$), while that of glucose, HDL-cholesterol and total cholesterol remained unaltered. The CMI response to intradermal injection of mitogen and humoral response (antibody titre) against PPR vaccination increased ($p<0.05$) with B-supplementation. The mineral profile in serum and the deposition of minerals in vital organs remained unaltered, except for Ca, which was increased ($p<0.05$) with B-supplementation. However, Mn in liver decreased ($p<0.05$) with B-supplementation. The carcass characteristics of the lambs were not influenced by the dietary treatments except for higher ($p<0.05$) weight of edible organs like spleen and kidney. Histopathological evaluation showed degenerative changes in liver and kidney of lambs fed Ca-deficient rations, which were ameliorated with 40ppm B-supplementation. Dietary B at 40ppm level did not show any adverse effects in liver, kidney or spleen and retained normal tissue architecture.

Boron supplementation improved calcium utilisation, immunity and growth performance, but did not affect tissue architecture of visceral organs.

APR 3.5: Utilization of nano zinc and its impact on growth and reproduction in goats

D Rajendran, SBN Rao, NKS Gowda and S Selvaraju

Nanotechnology has revolutionized the commercial application of nano sized minerals in the fields of medicine, engineering, information, environmental technology, pigments, food, electronics appliances, biological and pharmaceutical applications and many more. Nanoparticles have higher surface volume with decreasing size of the particles. At nano scale, the physical, chemical and biological

Table 3: Supplementation of graded level of Nano ZnO and its effect (Mean±SE) on immunity and sperm motility (%) in rats.

Treatment group	Immunity		Sperm Motility (%)
	Humoral: Serum Haemagglutination titre (log_2)	CMI: Foot pad thickness (mm)	
A (Control)	2.83±0.17^{a}	0.68±0.01^{a}	17.7±2.86^{a}
B (ZnO inorganic) ICAR Level	3.29±0.18^{ba}	1.16±0.06^{b}	31.8±2.24^{b}
C- ZnO (Nano) ICAR Level	3.67±0.21^{bc}	1.81±0.25^{c}	38.7±3.82^{bc}
D- ZnO (Nano) 1/2 Dose of C	3.17±0.17^{ba}	1.39±0.14^{bc}	37.5±3.22^{bc}
E- ZnO (Nano) 1/4 Dose of C	3.50±0.22^{cb}	1.24±0.25^{b}	36.6±2.65^{bc}
F- ZnO (Nano) 1/8 Dose of C	3.17±0.17^{ba}	1.18±0.13^{b}	29.9±2.15^{b}
G- ZnO (Nano) Double Dose of C	3.87±0.12^{c}	1.57±0.05^{bc}	43.8±3.08^{c}

properties of material differ fundamentally and often unexpectedly. These nanomineral particles are having higher potential than their conventional sources and thus reduce the quantity required. Studies describing the effect of nanoparticles on growth and reproduction are scanty. Zinc nano particles were synthesized using chemical methods and characterized.

To study the effect of nano zinc oxide, an *in vivo* trial was conducted with male Wister rats. Rats were divided into seven groups. Basal diet was prepared without zinc (A) supplementation and other groups were supplemented with inorganic zinc 25ppm (B), nano zinc 25 (C), 12.5 (D), 6.25 (E), 3.125 (F) and 50ppm (G), respectively. Digestion trial was conducted and animals were sacrificed and samples were collected for analysis. The results (Table 3) revealed that body weight gain, feed and water intake did not differ among the groups. Significant ($p<0.01$) increase in the sperm motility was observed in all the Zn supplemented groups than non supplemented group. The highest (43.86%) sperm motility was observed in group G and lowest in group A (17.71%). Humoral immunity was found to be more in nano zinc supplemented group C and G than Control Group A.

Zinc oxide nano particle could be prepared at laboratory level by chemical precipitation method. ZnO nanoparticles supplementation in rat significantly improved sperm motility. Supplementation of ZnO nano particle improves humoral immunity in male albino rats.

APR 3.6: Modulation of granulosa cell estradiol synthesis using copper and selenium

PSP Gupta, S Nandi, CG David, A Mishra and RU Suganthi

Sufficient levels of estradiol are required during the proestrous and estrous periods to elicit the lutenizing hormone surge that is responsible for ovulation. Based on sporadic work done on the effect of minerals on estradiol synthesis this project was conceptualized to test the effect of copper and selenium on granulosa cell estradiol synthesis and associated genes in goats with a long term objective of using these minerals to reduce the amount of hormone usage in reproductive management protocols like estrus induction and estrus synchronization.

Six-day culture system was followed for conducting the experiments to study the effect of minerals on *in vitro* ovarian granulosa cell estradiol synthesis. Copper at three doses (0.1, 0.5 and 1mM) and selenium at three doses (0.06, 0.6 and 6μM) in culture medium were tested to assess their effects on *in vitro* estradiol synthesis and the expression of associated genes in ovarian granulosa cells of goat. Copper at the dose of 0.5mM and selenium at the dose of 0.6 and 6μM significantly ($p<0.05$) increased the estradiol production. The mRNA expression of CCND2 and CYP19A1 (Fig. 10) in the granulosa cells after 6d of culture was estimated with

the first two doses of minerals. Copper (0.5mM) significantly ($p<0.05$) increased the mRNA expression of CCND2 in ovarian granulosa cells. However, there was no significant effect of selenium on CCND2 mRNA expression. The mRNA expression of CYP19A1 was significantly ($p<0.05$) increased with 0.5mM dose of copper and 0.06 and 0.6μM doses of selenium. When the copper and selenium were supplemented in combination the stimulatory effect on the estradiol synthesis and associated genes was more prominent than when they were supplemented alone.

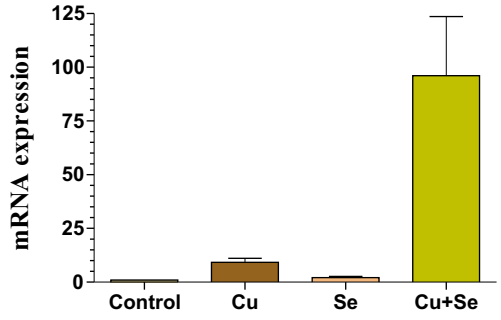


Fig. 10: Effect (Mean±SE) of copper (Cu 0.5mM) and selenium (Se 0.6μM) either alone or in combination on in vitro ovarian granulosa cell expression of CYP19A1 mRNA in goat.

Copper and selenium either alone or in combination promoted the ovarian granulosa cell estradiol synthesis and upregulated estradiol synthesis associated genes in goats.

APR 3.7: Modulation of myostatin through different wavelengths of light and RNAi in broiler chicken

IJ Reddy, A Mishra, S Mondal, RK Gorti and VB Awachat

The work involved manipulation of light intensity and its effects on broiler production by modulating GnRH, stimulating satellite cells and myostatin suppression in broiler chicks.

Embryonated eggs from 5d on wards were exposed to 450nm (normal), 675nm (red), and 575nm (green) wavelengths of light till hatching. Hatched pullets were reared under normal husbandry condition until 6 weeks of age. All the post hatch chicks in all the groups were fed as per the standard specifications. Blood samples were collected from all the birds at regular intervals for estimation of GH, FSH, IGF1, leptin, testosterone, estradiol-17β (E2β), cortisol, T3, T4 hormones. Body weight gain, feed intake, feed-to-gain ratio (FCR) was recorded in all the groups. Tissue samples were collected from all the groups for GnRH, GnIH, MSTN, leptine, actin and myogenin gene expression.

From 5d of incubation until hatch, eggs were exposed to normal, red and green spectrum of light. Eggs exposed to green light increased embryonic weight after 14d of incubation and resulted in higher percentage of body weight compared to other two groups. Broilers photostimulated *in ovo* with green light showed low feed consumption and low FCR during post hatch period. Continuous *in ovo* stimulation with green light accelerated the early body weight gain (10 to 12d) with concomitant increase in pectoral muscle weight ($p<0.01$) at 35d post hatch as compared to control group. *In ovo* stimulation with green light led to more satellite cells with more muscle mass and low abdominal fat at day-42 post hatch. It was observed that stimulating *in ovo,* with green LED and rearing birds under normal light showed significant ($p<0.01$) additive effect on GH, IGF1, FSH, testosterone, E2β, T3 and T4 (Table 4). Cortisol levels were not altered in all the groups. Profiling of GnRH, GnIH, GH and myostatin gene expression in tissues are on progress.

Continuous in ovo stimulation with green light accelerated the early body weight gain with concomitant increase in pectoral muscle weight at 35d post hatch as compared to control group in broiler chicken. In ovo stimulation with green light also led to more satellite cells with more muscle mass and low abdominal fat at 42d post hatch.

APR 3.8: Effect of dietary selenium on selenoprotein genes in lambs

RU Suganthi, PK Malik, J Ghosh, VB Awachat and P Krishnamoorthy

Dietary Selenium (Se) is essential for growth, immunity and reproduction and is an important factor in determining optimal health and disease susceptibility of sheep. The biological function of selenium are carried out primarily by selenoproteins that contain the 21st proteinogenic amino acid,

Table 4: Effect (Mean±SE) of different wavelengths of light on endocrine and breast muscle parameters in broiler chicken.

Parameter	Control (450nm)	Red (675nm)	Green (575nm)
GH (ng/ml)			
35d	5.21±1.15[a]	6.01±0.64[a]	9.11±1.11[ab]
42d	5.71±0.97[a]	6.11±0.44[a]	9.16±0.85[ab]
IGF-1 (ng/ml)			
35d	12.7±1.21[a]	14.1±0.98[a]	20.1±1.14[ab]
42d	12.5±0.99[a]	14.6±0.98[a]	22.9±1.36[ab]
Testosterone (pg/ml)			
35d	75.5±1.30[a]	112.6±0.64[a]	189.6±1.11[ab]
42d	80.9±1.99[a]	116.9±1.74[a]	142.6±1.85[ab]
Thyroxin (ng/ml)			
35d	20.2±0.31[a]	24.1±0.62[a]	28.1±0.22[ab]
42d	22.6±0.16[a]	24.9±0.18[a]	29.6±0.24[ab]
Cortisol (ng/ml)			
35d	1.15±0.14	1.31±0.90	1.29±0.13
42d	1.11±0.13	1.12±0.09	1.22±0.15
Breast muscle of BW %			
0-21d	16.4	17.0	17.5
0-35d	16.3	17.4	17.7
0-42d	17.5[a]	18.2[a]	20.1[ab]

[a,b] indicates a significant difference (p<0.05) within a row

selenocysteine. The project aimed to study the effect of dietary selenium on antioxidant status, immune status, meat quality and expression of selenoprotein genes in sheep by feeding different levels of selenium.

An experiment was conducted in male lambs by feeding basal diet (control) and basal diet with 0.5, 1.5 or 4.5ppm of organic selenium respectively for 90d. To assess plasma antioxidant capacity, the Folin-Ciocalteu reagent Assay (FCR) and the ferric reducing antioxidant power (FRAP) assay were performed. Results of FCR assay showed a higher antioxidant status in animals supplemented with higher levels of selenium (Fig. 11). With respect to immune response to PPR vaccine, a dose dependent increase in the antibody titre was observed on the day-21 after PPR vaccination (Table 5).

Table 5: PPR antibody titre (Mean±SE) after PPR vaccination. [a,b,c] indicates p<0.05.

Treatment	PPR antibody titre, day-21
Basal diet (Control)	74.9±0.80[a]
Basal diet+0.5ppm Se	76.9±2.38[ba]
Basal diet+1.5ppm Se	82.9±2.97[bc]
Basal diet+4.5ppm Se	85.4±1.55[c]

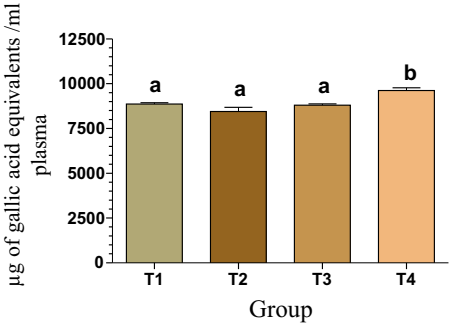


Fig. 11: Folin-Ciocalteu Assay (Mean±SE) of plasma (Day-60); T1, T2, T3 and T4 indicates 0, 0.5, 1.5 and 4.5 ppm Se supplementation respectively, a, b indicates p<0.05.

A positive trend in antioxidant and immune status was observed in sheep supplemented with organic selenium.

APR 3.9: Nutritional conditioning for neonatal programming in broiler chicken: Gut development and Immunity

AV Elangovan, NKS Gowda, J Ghosh, CG David and VB Awachat

The project aimed to explore the developmental patterns of gastrointestinal and immune system in

response to pre-hatch and neonatal supplementation of amino acids and trace mineral.

An experiment was conducted to test the efficacy of amino acids (lysine, methionine and threonine). On 18d of embryonic age, eggs showing viable embryo were injected with amino acids into amnion using a 24G hypodermic needle (25mm long). Post-hatch chick were distributed replicate wise into 4 experimental groups: 1) Control (normal hatch-normal broiler diet); 2) Normal hatch fed with scaled up nutrients for 3d; 3) *In ovo* supplemented fed with normal diet; 4) *In ovo* supplemented fed with scaled up nutrients for 3d. The experiment was conducted until 5wks of age. The results indicated significant improvement in body weight gain of chick's *in-ovo* supplemented and scaled up nutrients. Breast meat was also enhanced in the scaled up nutrient group. Immune response was not affected due to treatment.

A second experiment was conducted to test the efficacy of different sources (Zn sulphate, Zn methionate, nanoparticle of Zn oxide) of Zn as *in ovo* nutrient. A dose of 0.5mg/egg was found to be toxic which was reflected in terms of poor hatchability. *In ovo* injection of Nano Zn at the rate of 80microgram/egg did not alter the growth performance, gut development and immunity of broiler chicks.

Supplementation of amino acids may be beneficial during the perinatal phase of broiler chicken.

APR 3.10: Development of a novel semen extender for improved post-thaw motility of cryopreserved buffalo semen

SC Roy, A Dhali and KS Roy

Semen cryopreservation is an indispensable tool to preserve and propagate elite germplasm for breeding and improvement of farm animal species. However, the post-thaw motility and the associated fertility of cryopreserved sperm is found to be reduced substantially making it a major impeder of success of artificial insemination. It has been observed that the average post-thaw motility and fertility of frozen-thawed buffalo spermatozoa is substantially low as compared to that of cattle sperm. One of the major causes of this species-specific variation in post-thaw sperm motility and fertility rate may be due to variation in sperm structure and seminal plasma composition of buffaloes as compared to that of cattle and use of inappropriate semen extender. The other most potent contributing element identified in other species is the cryopreservation-associated oxidative membrane, protein and DNA damages of sperm. Over the decades, the composition of semen extender used for diluting buffalo semen and protocols used for subsequent cryopreservation remains primarily similar to that of cattle and this may primarily be leading to variation in the extent of cryodamage and post-thaw sperm motility in this species. Further, the detail molecular mechanism and extent of cryopreservation-associated structural damages to sperm and their mitigation strategies have not been explored systematically for buffalo semen. Thus, there is an urgent need to develop a species-specific semen extender for buffalo based on its seminal plasma composition and incorporating some of the promising agents that can minimize the above-mentioned cryopreservation-associated oxidative stress in sperm, which in turn may improve the post-thaw motility and associated fertility of cryopreserved buffalo semen. The present study has been designed in that direction. Buffalo semen samples were collected and processed for cryopreservation using standard protocol. The extent of cryopreservation-associated oxidative lipid peroxidation was assessed in terms of formation of malondialdehyde (MDA, an end product of lipid peroxidation) in extended semen before and after cryopreservation. Attempt was also made to analyze various metabolites (viz. amino acids and neurotransmitters) in both buffalo and cattle seminal plasma. The level of MDA concentration in extended buffalo seminal plasma of 30d cryopreserved semen increased significantly ($p<0.05$) as compared to that of non-cryopreserved semen. (3.480.24 Vs. 2.270.19picomoles/100×10^6 sperm). Buffalo

seminal plasma demonstrated significantly lower ($p<0.05$) levels of hydroxyproline, alanine, tyrosine, methionine, leucine and tryptophan as compared to that of cattle seminal plasma. On the contrary, buffalo seminal plasma demonstrated significantly higher ($p<0.05$) levels of taurine and amino adipic acid as compared to that of cattle seminal plasma.

It was observed that buffalo sperm suffers a significant degree of lipid peroxidation after a cycle of freezing and thawing. The seminal plasma of buffalo semen differed significantly in terms of metabolite composition as compared to that of cattle.

APR 3.11: Development of ideal protocol for isolation and culture of ram spermatogonial stem cell

BK Binsila, S Selvaraju and A Arangasamy

The spermatogonial stem cells (SSCs) are unique testicular cells having the ability to regenerate their own pool of cells and alternatively differentiate into functional spermatozoa. The SSCs provide an ideal model to understand the molecular mechanism involved in spermatogenesis, regulation of male fertility and also improve male fertility by transplantation of superior quality SSCs. Hence the current study aims for isolation and identification of SSCs from sheep testicular tissue.

Pre pubertal ram testis were collected from slaughter house. The tissue homogenate was used to isolate SSCs using enzymatic digestion (collagenase, trypsin and hyaluronidase) in different combinations and concentrations. The duration of incubation for each enzymes set were collagenase: 1h, Hyaluronidase: 10min, trypsin: 5min at 37°C. Following isolation, the viability was assessed by trypan blue staining and initial screening of SSCs using alkaline phosphatase assay (Table 6). The percentages of SSCs in each isolate were determined by promyelocytic leukaemia zinc finger protein (PLZF; SSC marker) positive cells in immunocytology smears. The testis tissue sections were processed for immunolocalization using PLZF (Fig. 12).

The two step enzymatic method yielded SSCs with stem cell activity, which was confirmed by PLZF and alkaline phosphatase test. The percentage of viable, alkaline phosphatase positive and PLZF positive cells ranged from 70 to 78%, 9.62 to16.3% and 4.5 to 7.25%, respectively in various groups. Group II (collagenase: 2mg/ml, trypsin: 0.5mg/ml) yielded higher percentage of viable and PLZF positive cells.

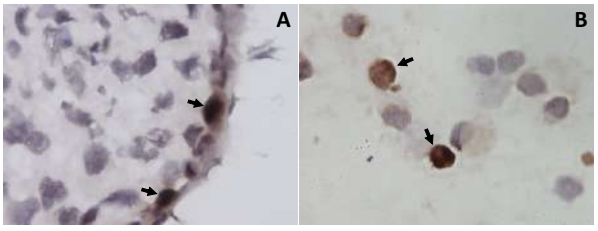


Fig.12: Immunolocalization of promyelocytic leukaemia zinc finger protein (PLZF), spermatogonial stem cell specific marker. A: testis tissue section, B: cell isolate.

The enzymes collagenase at 2mg/ml for 1h and trypsin for 5min at 37°C were found most suitable for SSCs isolation from prepubertal ram testis. SSCs identification in testis and cell isolate was confirmed by SSC marker PLZF.

Table 6: Percentage (Mean±SE) of viable cells, positive for alkaline phosphatase assay (APA) and promyelocytic leukaemia zinc finger protein (ICC) in various experimental groups.

Parameters	Group I, N=6	Group II, N=6	Group III, N=6	Group IV, N=6
Viability (%)	77.2±2.59	78.3±3.06	73.6±8.99	70.0±4.36
APT (%)	16.3±2.67[a]	13.3±2.03[b]	11.8±1.62[b]	9.62±2.14[b]
ICC (%)	4.5±1.14[a]	7.25±0.66[b]	6.10±0.78[a]	5.00±1.05[a]

[a,b] *indicates a significant difference ($p<0.05$) within a row*

APR 3.12: Development of pregnancy associated glycoprotein (PAG) based immunodiagnostic for buffaloes (*Bubalus bubalis*)

J Ghosh, KS Roy and CG David

In different ruminant species the trophoblast cells at the feto-maternal interface secrete an inactive aspartic proteinase family of proteins called pregnancy associated glycoprotein (PAG). The detection of this protein in maternal circulation during early conception formed the basis of early pregnancy diagnosis in ruminants. Previously, the majorly expressed transcript in early buffalo cotyledon was determined in our laboratory and recombinant protein (PAG) of the transcript was produced in *E coli*. Anti-sera raised against the recombinant buffalo PAG was found to react with the early pregnant cotyledonary proteins and showed limited cross reactivity with the non-pregnant uterine endometrial tissue proteins. At his context, the current project was designed to develop buffalo PAG specific immuno-assay (EIA/RIA) using purified antigen and antibodies and test the efficacy of the assay in pregnant and non-pregnant buffalo serum/plasma samples.

The BL21 (DE3) competent *E. coli* cells were transformed with the PAG inserted PET protein expression vector. The insert contained codon modified desired 372bp sequence coded for 124aa of buffalo PAG major expressed transcript in placental cotyledon. The transformed cells were selected by application of antibiotics in broth culture. Expression of protein was induced by IPTG. Positive expression of protein was verified by SDS-PAGE analysis and Western blot detection. The PAG specific antibody generated based on the recombinant protein was used for detection of expressed PAG protein by SDS-PAGE and Western blot analysis (Fig. 13).

The protein was produced in bulk culture, cells harvested and purified by NiNTA column affinity chromatography. The recombinant protein was used for production of antisera previously. The antiserum was purified using immuno affinity column chromatography. The affinity purified antibody was used for determination of optimum dilution in checker board analysis. The purified antigen in different dilution was used for labeling by biotin and radio iodine for using in competitive binding assay development. Initial trial showed promise for enzyme immune assay but not the radio immune assay. Attempt is on to standardize and develop a better labelling protocol for the antigen.

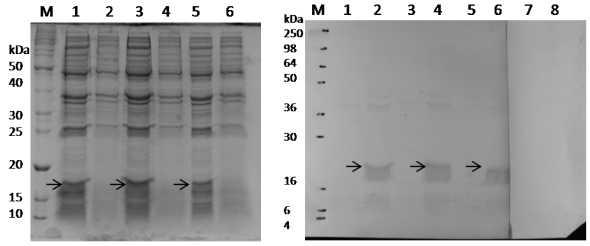


Fig. 13: Detection of recombinant PAG proteins in E coli cell extract. Panel-A: Coomassie blue stained image of 15% acrylamide gel showing expressed protein band (arrow) in the 1mM IPTG induced cell extracts (lanes 1,3,5) against the non induced cell extract (lanes 2,4,6). Panel-B: Western blot image showing immune-reactive protein band (arrow) in induced cell extract (Lanes 2, 4, 6, 8). Lanes 1,3,5,7 represent the non-induced cell extract. Lanes 7 and 8 were used as negative control (no primary antibody). M indicates standard molecular weight protein marker.

Recombinant buffalo PAG was produced in bulk, antisera was raised against the recombinant protein and development of immuno assay was attempted for detecting early pregnancy in buffalo.

ICAR-AICRP: Nutritional and physiological interventions for enhancing reproductive performance in animals

Coordinator: R Bhatta

JP Ravindra, IJ Reddy, NKS Gowda, DT Pal, KS Roy, S Selvaraju and BK Binsila

The AICRP was initiated in 2014-15 with 12 centres throughout India and is coordinated by ICAR-NIANP to assess the extent of infertility conditions and possible interventions through nutritional and physiological means in animals. The overall objectives encompass documentation of current status/extent of infertility and various causes of reproductive failures, ameliorative measures for overcoming infertility conditions including their validation to develop package of practices for application under field conditions for overcoming reproductive problems in cattle and buffaloes.

During the reported period, survey was conducted and data/samples were collected from North (Bidar Dt), North west (Sirsi Tk), South west (Puttur Tk), Central (Davangere Dt) and South (Bengaluru urban

and rural Dt) Karnataka covering 35 villages. The data collected from 1126 animals revealed that 21% of the animals had reproductive problems and among the reproductively problematic animals, 57% were repeat breeders. Among the repeat breeders, 54% had luteal insufficiency and among the postpartum anoestrus animals, 19% were having silent oestrus. BUN and HDL cholesterol were low in delayed pubertal animals (Table 7). Among reproductive problematic animals, 48% were found to have negative energy balance. The plasma Ca, P, and Zn were found deficient in animals with reproductive problem (Table 8). The regional macromineral profile (Fig. 14) analysis revealed that the Puttur region is deficient in calcium and Sirsi region is deficient in magnesium. The regional micromineral profile (Fig. 15) indicates that the Davangere region is deficient in copper. IGF1 at the level of 150ng/ml was found to significantly improve post-thaw viability and acrosome intactness and protected sperm function during cryopreservation process by protecting sperm membrane proteins such as CALM1, DCD and SPACA3 (Fig. 16). The higher proportion of immune regulatory protein in low fertile bulls and differential expression of these proteins between the bulls differing in fertility were established. The results provide novel insights into selection of semen that might favour successful fertilization and could determine the fertility status of a male. It was also revealed that the cfs-mRNA can be used to predict the sperm susceptibility to cryoinjury. Cows with reproductive problem were treated with double estrous synchronization protocol along with fixed time AI. Camel sera samples (N=172) from NRC on Camel, Bikaner were assayed for testosterone hormone through ELISA.

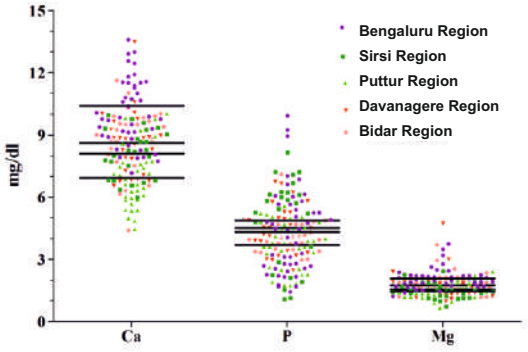


Fig. 14: Regional macromineral profile of various regions of Karnataka State.

Table 7: Plasma biochemical profile (Mean±SE) in normal animals and animals with reproductive problem.

Groups	BUN (mg/dl)	Protein (g/dl)	Cholesterol (mg/dl)	HDL cholesterol (mg/dl)	NEFA (mmol/l)
Normal, N=58	9.26±0.51	8.70±0.54[a]	155.1±8.94	85.1±3.55[a]	0.46±0.01
Repeat Breeder, N=40	9.83±0.81	8.24±0.56[a]	164.4±10.6	96.9±5.41[a]	0.45±0.01
Postpartum Anoestrus, N=18	8.11±0.72	8.90±0.93[a]	139.6±15.7	84.5±5.73[a]	0.48±0.01
Delayed Puberty, N=13	6.16±0.51	8.98±0.94[a]	138.4±20.6	67.7±67.7[b]	0.41±0.04
Silent heat, N=7	8.42±0.57	6.79±0.17[b]	148.3±11.7	74.0±9.71[b]	0.45±0.02

[a,b] *indicates a significant (p<0.05) difference within a column*

Table 8: Plasma mineral profile (Mean±SE) in normal animals and animals with reproductive problem.

Particulars	Groups				
	Normal N=54	Repeat Breeder N=40	Postpartum Anoestrus, N=18	Delayed Puberty N=13	Silent heat N=7
Calcium (mg/dl)	9.23±0.3[a] (26)	8.50±0.3[b] (33)	9.18±0.6[a] (39)	8.13±0.6[b] (38)	7.03±0.4[b] (86)
Phosphorus (mg/dl)	4.86±0.3 (30)	4.02±0.3 (48)	4.21±0.31 (39)	3.86±0.39 (62)	3.80±0.29 (71)
Magnesium (mg/dl)	1.90±0.1(41)	1.76±0.1 (70)	1.87±0.17 (67)	1.76±0.10 (69)	1.50±0.17 (71)
Zinc (mg/l)	1.13±0.08[a] (24)	1.03±0.11[a] (60)	1.01±0.11[a] (28)	1.26±0.17[a] (46)	0.65±0.11[b] (57)
Iron (mg/l)	2.49±0.10 (4)	2.36±0.14 (8)	2.35±0.25 (-)	2.19±0.15 (-)	2.30±0.19 (-)
Copper (mg/l)	0.91±0.08[a] (22)	0.87±0.06[a] (40)	0.81±0.10[a] (50)	0.75±0.03[b] (31)	0.68±0.14[b] (43)

[a,b] *indicates a significant (p<0.05) difference within a row. Value in parenthesis indicates Percentage of animals showing mineral deficiency*

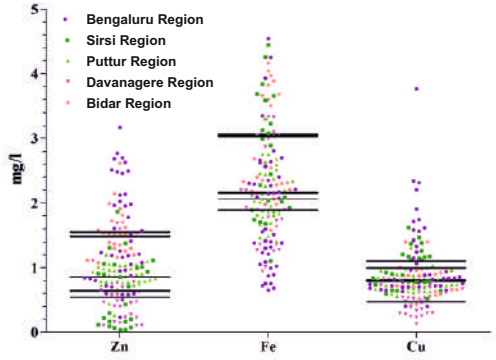


Fig. 15: Regional micromineral profile of various regions of Karnataka State.

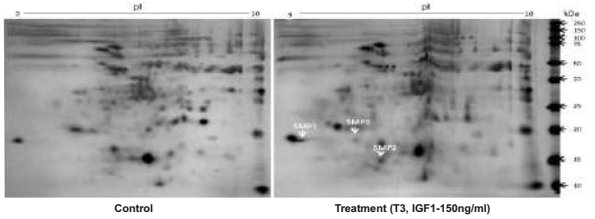


Fig. 16: Identification of spermatozoal proteins in IGF-1 treated (T3) and untreated (C) groups using two dimensional electrophoresis. SMP1: Calmodulin (Mw 17.3kDa, pI 4.22); SMP2: Dermcidin (Mw 11.3kDa, pI 6.54), SMP3: Sperm acrosome membrane associated protein (Mw 18.1kDa, pI 5.4).

IGF1 treatment significantly improved post-thaw viability and acrosome intactness and protected sperm function during cryopreservation. Higher proportion of immune regulatory protein in low fertile bulls and differential expression of these proteins between the bulls differing in fertility were established.

ICAR-Outreach: Monitoring of drug residues and environmental pollutants

KS Prasad , SBN Rao and DT Pal

The widespread use of pesticides in agricultural practices and ectoparasiticides in livestock and other environmental pollutants like heavy metals are directly/through soil, water and feeds, lead to the presence of these residues in edible products of animal origin (milk, meat and eggs). This centre is monitoring environmental pollutants in soil, water, feeds, fodders and animal products with the objectives to standardize process for determination of pollutants in soil, feeds, fodders and animal products in selected areas of Karnataka using modern and precision methods.

A Total of 240 samples were collected from 17 villages in three taluks of Raichur district. Eighty farmers were covered for the study. The area grows mostly paddy, cotton and bengal gram. It was observed that most of green and dry fodder samples were contaminated with chloropyriphos, but no sample exceeded MRL. One sample was found contaminated with cypermethrin, but was within MRL. Presence of arsenic was negligible, where as a few samples contained cadmium and lead.

Milling by-products rice bran, polish and oil cakes are consumed by majority of the dairy animals in this region. No gamma-BHC, endosulphan, pp'DDT, deltamethrin were found in these samples. However, majority of the samples were contaminated with chloropyriphos residues, but levels did not exceed MRL. In one samples o,p-DDT contamination was detected. Arsenic was absent in concentrates, but a few samples contained cadmium and lead.

Very few samples of buffalo milk were found contaminated with gamma-BHC and DDT, but in all samples the presence of chloropyriphos was detected. In one sample endosulphan was also detected. Other pesticides, such as cypermethrin and deltamethrin was found absent in milk samples. The collected milk samples showed no contamination of arsenic, but in a few samples lead was present. However, all the milk samples contained Cadmium contamination. The contamination of milk with Lead and Cadmium content was comparatively higher in Raichur Taluk than Manvi Taluk in the district. Few water samples in the area were found contaminated with chloropyriphos, Arsenic and Lead. Cadmium was found negligible in soils, but Arsenic and Lead were present in a few soil samples. The presence of Arsenic, Lead and Cadmium was also detected in hair samples.

Most of the feeds and milk samples were detected with chloropyriphos. All the milk samples contained Cadmium and in a few samples Lead was detected. The presence of Arsenic, Lead and Cadmium was also detected in hair samples.

ICAR-NASF Project: Enhancing development competence of oocytes for better in vitro fertilizing ability

A Dhali, AP Kolte, SC Roy and V Sejian

The project aimed to elucidate the functional biology of sheep oocytes by synergizing oocyte's cellular, transcriptional and molecular interaction networks to design strategies for providing artificial competence to oocytes for enhancing their fertilizing ability and post-fertilization development *in vitro*.

Whole transcriptome analysis of the BCB screened GV stage sheep oocytes and 2-cell embryos generated from BCB screened oocytes were performed. KEGG pathway analysis of the transcriptome data revealed 23 and 19 enriched pathways, respectively in the oocytes and embryos of better development quality. MA plots (Fig. 17) were generated to compare the gene expression profiles between the different oocyte-embryo groups. Further, the list of exclusively expressed (mutually exclusive) transcripts in oocytes and embryos was derived from the oocyte and embryo trnascriptome data (Fig. 18). Widest dispersion in the gene expression profile was observed when the transcriptome profile of poor oocytes was compared with transcriptome profile of either good or poor embryos. It was observed that a total number of 149 and 168 transcripts could be detected only in the good and poor embryos respectively, but these transcripts could not be detected in the oocytes of any group. The results indicated that these transcripts were either delivered through sperm during the process of fertilization or contributed through the embryo's own gene activation.

Cumulus cells play a crucial role in the oocyte maturation and subsequent embryo development through many secretary factors, which are produced by these cells. Therefore, the differential expression pattern of the important development related genes (N=14) in the cumulus cells of good (BCB+) and poor (BCB-) sheep oocytes was assessed at the different stages (0, 12 and 24h) of *in vitro* maturation. It was observed that the gene expression pattern significantly changes as maturation progressed.

It was indicative that the poor oocytes tried to compensate the lag in the development process that was reflected in the over expression of the important genes, which helped in the maturation process of oocytes. Further, at the completion of *in vitro*

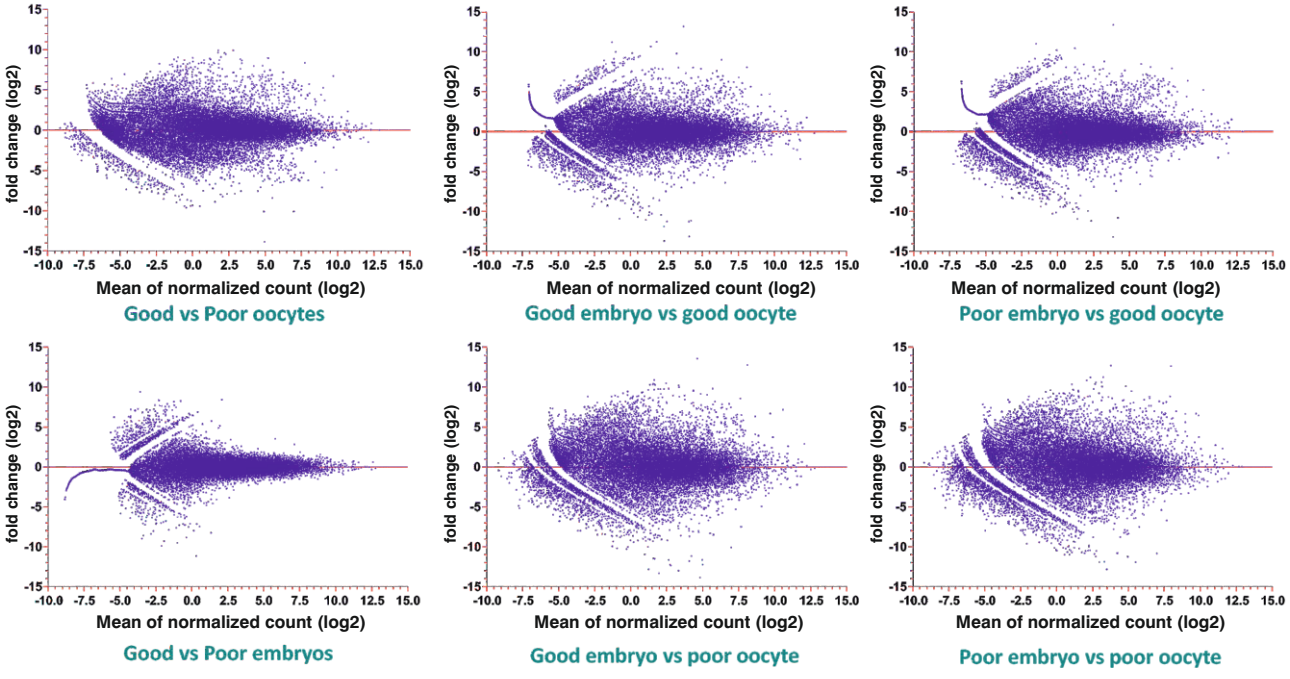


Fig. 17: Comparison of gene expression profiles between the different oocyte-embryo groups

maturation, it was observed that more number of favourable genes was over expressed in the poor oocyte. The results suggested that compensatory development regulation in the poor oocyte existed during the course of *in vitro* maturation.

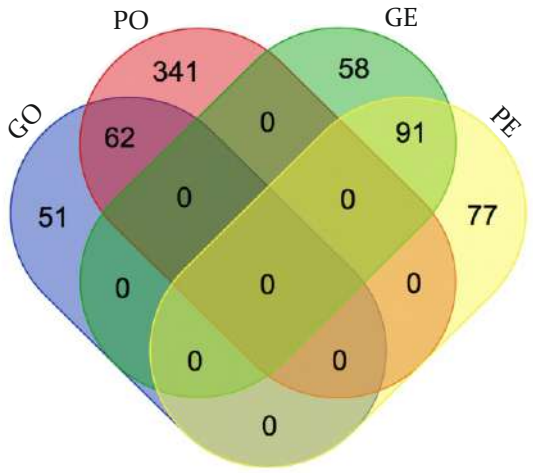


Fig. 18: Presence of unique transcripts in oocytes and 2-cell embryos. G: good (BCB+), P: poor (BCB-), E: embryos, O: oocytes

The transcriptome analysis of oocytes and 2-cell embryos revealed a marked difference in the enriched pathways between the oocytes and embryos of good and poor development competence. The data revealed that PI3K-AKT and MAPK signals were crucial for oocyte and embryo development and were found enriched in the good oocytes and embryos. Therefore, attempt was made to stimulate these signals through EGF and IGF1 supplementations to achieve better oocyte maturation and post-fertilization embryo development. It was observed that IGF1 supplementation significantly ($p<0.05$) improved the cleavage rate of good oocytes. Although, the rate of 4-8 cells, morula and blastocyst did not differ among the groups, but these rates were found greater in the good oocytes when matured in the presence of IGF1. The results indicated that although IGF1 could stimulate oocytes maturation and post-fertilization cleavage, but it was not sufficient to stimulate the embryo development at later stage. Similarly, EGF supplementation in both IVM and IVC media significantly ($p<0.05$) stimulated the embryo development into 4-8 cell stage, but was not sufficient to stimulate embryo development at the later stage.

A marked difference in the cellular and biological functions between the oocytes and 2-cell embryos of good and poor development competence was evident. Based on the results of transcriptome data, important cellular process were identified which hold promise for manipulation to stimulate in vitro oocyte and embryo development in sheep.

DBT Project: Bioconversion of agricultural wastes for production of nutraceuticals to improve the gut health in animals

AK Samanta and M Sridhar

The study was focused on the process optimization for production of xylooligosaccharides from the xylan of different agricultural wastes. Three agricultural wastes namely cotton, tobacco and bajra stalks were used for xylan extraction followed by production of xylooligosaccharides (XOS). Among the three agricultural wastes, hemicellulose content (%) was highest in bajra stalks (27.9±1.57), followed by tobacco stalks (16.9±0.65) and cotton stalks (14.8±0.75). Application of potassium hydroxide (8%) solution coupled with steam (for a period of 45min) enabled highest (>90% of original contents) recovery of xylan from all the above three agricultural wastes. Fourier Transform Infrared Spectroscopy (FTIR) and Thermo-Gravimetric analysis (TGA) of the extracted xylan revealed absence of cellulose or lignin. The Xylan of these agricultural wastes were grounded and subjected to hydrolysis by commercial xylanase. The xylooligosaccharides produced were detected on TLC plates and quantified by both colorimetric (in terms of reducing sugars) and HPLC analysis. TLC analysis indicated degradation of xylan into short chain oligosaccharides in the enzymatic hydrolysate of xylan. In case of cotton stalks xylan, the highest concentration (7.91±0.06 mg/ml) of reducing sugars was detected at a temperature of 50^{0}C, with 50U of xylanase enzyme in 50mM of citrate phosphate buffer of pH 5.0 for 8h of hydrolysis. The hydrolysis conditions such as pH 6.0, temperature 50^{0}C, and enzyme dose 20 U for 6 h of incubation enabled maximum (8.81±0.05mg/ml) levels of reducing sugars from the xylan of tobacco stalks. However, in case of bajra stalks xylan, the maximum

concentration of reducing sugars was found to be 10.2±0.10 mg/ml at 50°C with 20U of enzyme in 50mM citrate phosphate buffer of pH 5.0 for 8h of incubation. HPLC analysis of bajra stalks xylan revealed 1.5mg/ml of xylooligosaccharides could be achieved at 50°C temperature, pH 6.0 for a hydrolysis time of 6h with application of 5U of xylanase enzyme. Temperature and time had significant ($p<0.05$) effect on the yield of total XOS and Xylose. The pH had significant ($p<0.05$) influence on the yield of Xylobiose (X2) and Xylotriose (X3). The enzyme dose exhibited significant ($p<0.05$) impact on the yield of all three xylooligosaccharides (X2, X3 and X4) as well as xylose.

The xylooligosaccharides from the xylan of bajra stalks was produced in bulk quantity to test its potentiality against gut pathogens in broiler chicks reared on deep litter system. About 150 number of day old (Vencob) broiler chicks were divided into five groups with 30 chicks in each treatment for a period of 3 weeks. The treatment combinations were: Group I: control diet; Group II: control diet fortified with 0.5% xylan; Group III: control diet and birds were challenged with *E. coli* ATCC 10536 (2×10^9 cells/bird oral); Group IV: control diet plus 0.2% chlortetracycline and birds were challenged with *E. coli ATCC* 10536 (2×10^9 cells/bird oral); and Group V: control diet plus 0.5% xylooligosaccharides and birds were challenged with *E. coli* ATCC 10536 (2×10^9 cells/ bird oral). No significant effect was noticed on body weight gain, feed conversion efficiency, blood lipid profile due to xylan supplementation. Further, challenging with established poultry pathogens was unable to bring out visible adverse affects on litter, but sporadic diarrhoea was noticed in few birds. No significant difference was noticed as a result of administering xylooligosaccharides in experimentally challenged birds.

Three agricultural wastes namely cotton, tobacco and bajra stalks were used for xylan extraction and enzymatic production of prebiotic xylooligosaccharides. Xylan of bajra stalks was produced in bulk quantity and its potentiality against gut pathogens in broiler chicks was tested.

DBT Project: Immobilized fungal phytase production and its dietary evaluation in broiler and layer chicken

AV Elangovan, S Manpal and J Ghosh

The objectives of the project were to screen of *Aspergillus niger* and other promising species for phytase activity, immobilize and produce phytase enzyme, determine application rate and efficacy of phytase enzymes through feeding trials in broilers and layers and economize poultry production through the use of supplemental phytase enzymes.The phytase enzyme was purified by size exclusion chromatography using Sephacryl 200HR column and a single protein band in non reducing SDS-PAGE gel obtained indicated that the enzyme preparation was free from contaminating proteins. For cloning and sequencing of phytase gene, the total RNA from the *Aspergillus feotidus (*MTCC 11682) biomass was reverse transcribed and the partial coding region sequence was 1176bp long, codes for 391 amino acids and contained the core catalytic regions of the functional protein. The NCBI database search revealed that the core catalytic region had 99% homology with *Aspergillus niger*, *Aspergillus awamori*, *Aspergillus fumigates*, *Aspergillus oryzae* and *Aspergillus ficuum*, the other phytase producing fungal species.

To assess the efficacy of laboratory produced phytase on the egg production performance of layer chicken, a feeding trial of 16wk duration was conducted in a completely randomized design with five dietary treatments, with or without supplementation of laboratory or commercial phytase. The dietary treatments consisted of one positive control group, without supplementation of any phytase enzyme (T1: 0.32% available/non-phytin P) and four negative control groups which were supplemented with phytases (T2: 250 FTU/kg laboratory produced phytase with 0.24% available/non-phytin P; T3: 250 FTU/kg commercial phytase with 0.24% available/non-phytin P; T4: 500 FTU/kg laboratory produced phytase with 0.16% available/non-phytin P; T5: 500 FTU/kg commercial phytase with 0.16% available/non-phytinP) to meet the phosphorus requirements. The results of the

study indicated that the egg production, feed intake, egg weight, FCR and shell quality was not significant for the first 8wk of experimental feeding. However, there was a drop in egg production, feed intake and FCR in the next 4wk of experimental feeding in the group supplemented with lab phytase (500FTU/kg replacing complete source of inorganic phosphorus in diet). In conclusion, the lab phytase at the level of 250FTU/kg could replace 50% of inorganic phosphorus in diet and commercial phytase at the level of 500FTU/kg could replace complete source of inorganic phosphorus in the diet of layer chicken.

Partially purified fungal phytase at the level of 250 FTU/kg diet could replace 50% of inorganic phosphorus in the layer diet.

DBT Project: Expression of copper chaperones and transporters in copper deficient sheep

DT Pal, J Ghosh and CS Prasad

The objective of the project was to identify copper deficiency biomarkers by comparing the differential expression status of selected copper transporter and chaperone genes in sheep fed with copper adequate and deficient diets.

The dietary levels of copper affected the expression profiles of copper-related transporters and chaperone genes in sheep. The genes like ATOX1, SCO1, SOD and CCS were up-regulated and genes like CTR2, ATP7B, SCO2, COX11 and COX17 were down-regulated in whole blood and RBC samples. In liver tissues, SCO1, SCO2, SOD and CP gene were up-regulated and ATOX1, ATP7B, CCS, CTR2 and COX17 were down-regulated, but MURR1, COX11 and NRF1 gene expression remained unchanged. The validity of transcriptome data was established by qPCR of selected genes. Out of 18 transcripts used for validation, 17 showed the similar trends of expression as in NGS and one gene showed opposite trend (Fig. 19). Three transcripts, although regulated significantly in NGS, were found not significant by qPCR. Similarly, one transcript, although was not significant in NGS, exhibited significant regulation by qPCR. The positive qPCR signals in all the biological replicates proved the existence of these transcripts. In terms of differential expression in NGS and qPCR data, there were 94.4% agreement in the trend of expression, but when the significant changes were considered, only 78% of qPCR data was in agreement with the NGS due to inherent bias in the technology.

The differentially expressed transcripts were further analysed to understand the pathways affected in the upstream and down streams due to the changes in

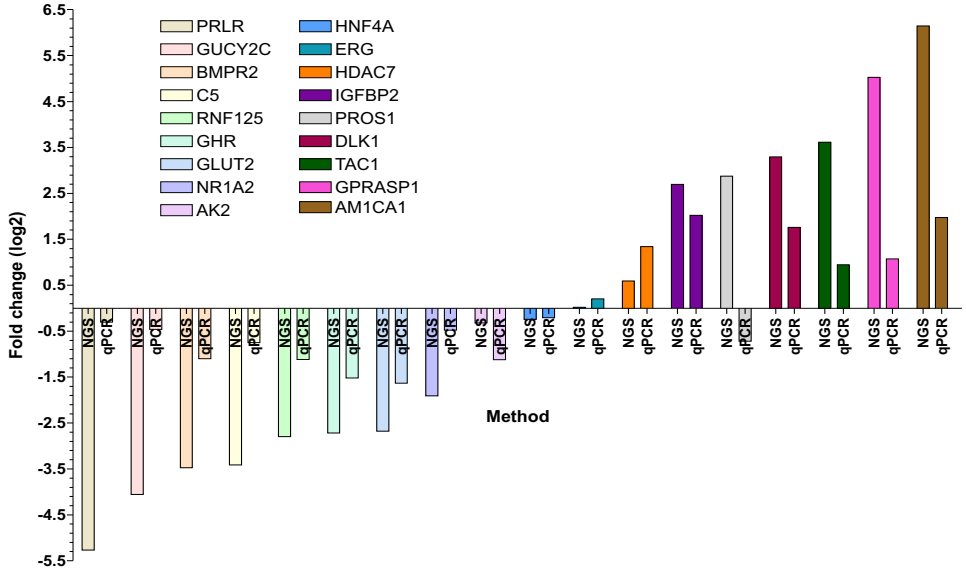


Fig. 19: Comparison of NGS and qPCR expression of different transcripts in biological replicates of copper adequate (n=3) and deficient (n=3) sheep. The fold changes are calculated from the expression ratios of the transcripts.

expression of these genes. A network was generated accordingly taking into account the interaction of the protein, genes and RNA (Fig. 20). The interactions considered were gene-gene, biochemical and protein-protein. The network analysis of all the differentially regulated genes of NGS showed multiple interacting genes (up/down regulated) with the hepatocyte nuclear factor-4-alpha (HNF4A) a member of the nuclear receptor family of transcription factors and is the most abundant DNA-binding protein in the liver. It regulates genes largely involved in the hepatic gluconeogenic program and lipid metabolism. However, the expression of this gene was found not affected in both NGS and qPCR data. The IGBP2 was found up regulated, but the growth hormone receptor (GHR) was found down regulated. The results indicated the logic of copper deficiency related growth performance.

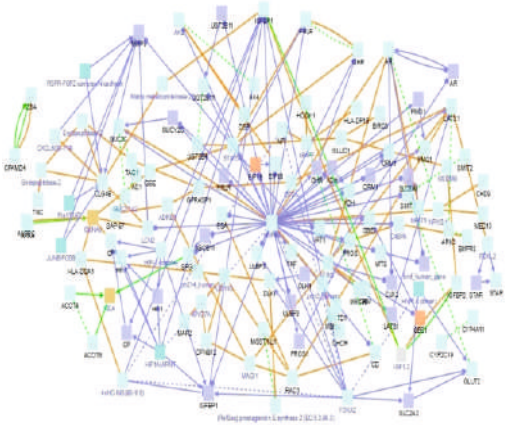


Fig. 20: Interaction map of differentially expressed genes. The colours of the nodes indicate type of molecule (blue: protein, purple: gene, orange: RNA). The colours of the lines indicate the type of interaction (purple: gene interaction, green: biochemical interaction, yellow: protein-protein interaction).

Dietary levels of copper affected the expression profiles of copper-related transporters and chaperone genes in whole blood, RBC and liver tissues in sheep.

DBT Project: Transcriptomic profiling of spermatozoa for selection of fertile bulls

S Selvaraju, JP Ravindra, AP Kolte, CG David and A Arangasamy

The conventional tests such as sperm progressive forward motility, sperm concentration and abnormalities to evaluate semen quality are not accurate predictors of bull fertility. Thus, there remains a need for molecular approaches for determining fertility in males. The composition and characteristics of sperm transcripts may vary among species, the present study focused on establishing the composition of the spermatozoa transcripts in bull to understand the factors associated with spermatogenesis, reasons associated with fertilization failure and embryonic mortality.

Twelve bulls were selected for RNA-Sequencing based on the field conception rate and functional parameters. The percentage of pregnancy rate for each Holstein-Friesian bulls in a batch of contemporaries (N=20; maintained at Nandini sperm station, Bengaluru) was calculated from approximately 1500 AI/bull. The bulls were selected based on the percentage point deviation (high fertile, N=6, average bull fertility index +3.0; and low fertile, N=6, average bull fertility index 5.0) of the pregnancy rate from the average fertility of their contemporary bulls. Four ejaculates were collected from each bull and assessed for motility and functional parameters.

From each bull, 1ml of whole semen from each ejaculate was aliquoted in 1.5ml tube and snap frozen in liquid nitrogen and stored at -80°C until RNA isolation. The remaining semen samples were cryopreserved using programmable freezer and stored at -196°C until analyzed for kinematic and functional parameters analysis. The RNA was isolated using the protocol developed in the laboratory (Fig. 21). The isolated total RNA was converted into cDNA and used for contamination and quality check. Intron spanning protamine 1 (PRM1) primer was used to detect contamination of gDNA in the RNA isolated from spermatozoa. To detect other cells' RNA contaminations (Fig. 22), cells specific primers were used for leukocytes (protein tyrosine phosphatase receptor type C, Ptprc), somatic cells (cadherin 1, Cdh1) and germ cells (kit oncogene, C-kit).

For RNA Seq, the libraries were prepared for two different platforms in order to obtain complete transcript profile. The Ion Proton library was

prepared using Ion total RNA-seq kit v2 without fragmentation, RNA enrichment and size selection. The constructed libraries sequenced in Ion Proton platform and generated 20million reads/sample. For the Illumina library preparation, total RNA was converted to double stranded cDNA using SMARTer Ultra-low input RNA kit followed by covaris shearing and end-repair of overhangs. The paired-end RNA sequencing library was prepared and sequenced using 2×75 paired end chemistry in NextSeq-500 to generate 20 million reads/sample. After analyzing the reads quality and trimming, the reads were mapped to bovine genome (Btau_4.6.1/Btau7) using CLC Genomics Workbench. The transcript expression levels were calculated based on the reads per kilobase of transcript per million mapped reads (RPKM).

The RNA isolation protocol used in the laboratory suggested optimum input concentration of 30 to 40 million cells for obtaining good quality RNA yield without contaminating substances. The bovine spermatozoa contain 20 to 30 fg of RNA and the RNA size distribution falls between 50 to 2000bp and also showed degraded ribosomal RNAs. Taken together from both the platforms, in bovine sperm, 4500 to 5000 transcripts were found moderately abundant (RPKM>5) and might regulate sperm function. The tRNA and novel unannotated (LOCs), brain expressed and diseases associated transcripts were found most abundant (RPKM>25) in bovine spermatozoa. In some specific transcripts, specific regions are retained and those retained region might regulate fertilization events. Some of the transcripts in spermatozoa are abundantly expressed in the placenta indicating its influence on the placental development. In high fertile bulls, 389 transcripts were significantly (>2 fold, $p<0.05$) upregulated and 138 transcripts were downregulated in spermatozoa. In high fertile animals, the most abundantly expressed transcripts were significantly associated with chromatin organization and chromosome organization. The spermatozoal transcripts were significantly ($p<0.05$) associated with various stages of spermatogenesis. These transcripts were involved in germ cell development (ZBTB16), mitosis (MAP7), meiosis (MLH1), chromatin condensation (PRM1 and TNP1) and regulation of apoptosis (BCL2L11). The upregulated (>10 fold) transcripts in high fertile bulls were associated with sperm maturation (WFDC2), anti apoptosis (BAG4), embryonic development (NR2E3), placenta development (ENDOU) and mesoderm formation and differentiation (T). The antimicrobial peptide defensin was found abundant (RPKM, >10) and the expression level significantly differ between high and low fertile bulls. The abundance of such mRNAs in sperm provides new window to understand the male factor towards infertility.

The RNA seq data were validated with qPCR experiments. The normalized expression levels of *BMP2* and *NGF* were significantly ($p<0.01$) higher in good than the poor semen producers. The relative expression levels of *BMP2* and *NGF* had a significant ($p<0.05$) positive influence on post-thaw sperm velocity parameters. The expressions of BMP2, NGF, IGF1, EIF1, CCT8 and PLCz1 transcripts were relatively higher in high fertile bulls as compared to low fertile bulls. The expression levels of cfs-RNA, NGF significantly ($p<0.05$) affected the sperm subpopulation positive for functional membrane and acrosomal integrities in neat semen. The expression levels of cfs-RNA, BMP2 significantly ($p<0.05$) influenced the percentage of Type A sperm in the neat semen samples.

The study suggests that spermatozoal transcripts can be used to understand the past events associated with spermatogenesis and possible functional role on fertilization and embryo development. The significantly differed transcripts might serve as a noninvasive tool to identify and select fertile bulls for AI programme

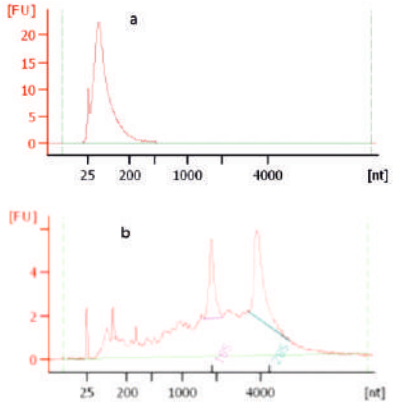


Fig. 21: The total RNA size distribution of sperm (A) and testis (B) by bioanalyzer.

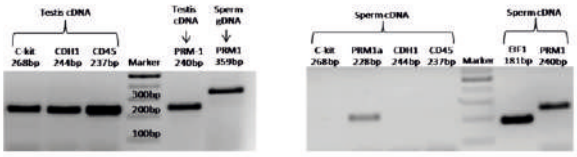


Fig. 22: The isolated RNA was checked for contaminating RNA from other cells. A: In testis, contaminating cells RNA were present. The intron spanning primer produced 240bp PRM1 and gDNA contamination resulted in 359 bp product. B: In sperm, only PRM1 primer produced expected product size indicating the sperm RNA without other cells contamination and the EIF1 and PRM1 were observed to be intact in spermatozoa.

The analysis of sperm transcriptome revealed the presence of 4500 to 5000 moderately abundant transcripts in bovine sperm that might regulate sperm function. The results suggest that spermatozoal transcripts can be used to understand the past events associated with spermatogenesis and its possible functional role in fertilization and embryo development.

DBT Project: Wnt signal mediated ovarian granulosa cell estrogen synthesis in ruminants

PSP Gupta, DT Pal, S Nandi and S Mondal

The pathways of estradiol synthesis in ovarian granulosa cells fallow cross talking between different pathways and complex mechanisms that are still not fully understood. WNTs are secreted extracellular signaling molecules that transduce their signals by binding to G protein-coupled receptors of the frizzled (FZD) family. The positive role of Wnt signal in estradiol synthesis of murine granulosa cells has been well established. There are few sporadic studies on the role of Wnt signal in the estradiol synthesis in domestic animals. Hence, the present research project was taken up to explore the role of Wnt signal in the FSH and non-FSH mediated ovarian granulosa cell estradiol synthesis in ruminants (buffalo/goat).

Dose of IWR for effective inhibition of FSH in both buffalo and goat ovarian granulosa cell estradiol synthesis was studied with the three doses 0.1, 1 and 10μM and the dose of 1μM was found to have maximal inhibitory effect on estradiol synthesis in ovarian granulosa cells. Studies on the effect of different doses of ovine FSH on buffalo and goat ovarian granulosa cell estradiol synthesis were conducted. Ovine FSH at the dose of 0.05mIU was found to be effective in the induction of estradiol synthesis in goat/buffalo ovarian granulosa cells in the *in vitro* culture system. Studies on the role of Wnt signal in the ovarian granulosa cell estradiol synthesis in different size categories of follicles were conducted in both buffalo and goats. There was a significant inhibition of estradiol by the Wnt Inhibitor (IWR) in the medium size category of ovarian follicles, which indicated that Wnt signal had a positive role in estradiol synthesis (Fig. 23). An additional study indicated that copper and selenium stimulated the ovarian granulosa cell proliferation and estradiol synthesis in ruminants. Both minerals stimulated Wnt signaling that enhanced estradiol synthesis through Non-canonical Wnt Signalling pathway. Copper and Selenium significantly up regulated the CYP19A1 and CCND2 gene expression when added in combination. Copper and Copper+Selenium significantly up regulated the gene expression of WNT2 and Axin2. Copper and Selenium either alone or in combination significantly down regulated the CateninB1.

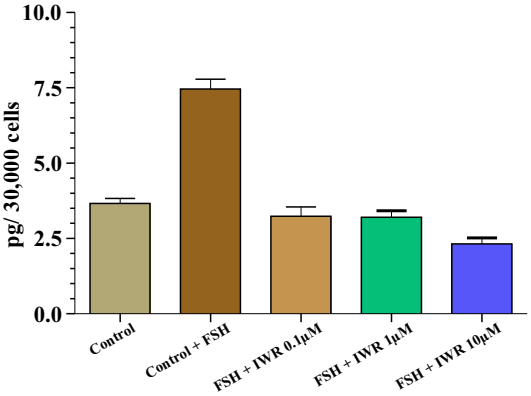


Fig. 23: Effect (Mean±SE) of different doses of Inhibitor of Wnt response (IWR) on secretion of estradiol from ovarian granulosa cells of buffalo after 6 days of culture.

Wnt signal was found to have a stimulatory role on the ovarian granulosa cell estradiol synthesis in buffalo. Copper and selenium improved ovarian granulosa cell estradiol synthesis in goat. Both minerals stimulated Wnt signalling that enhanced estradiol synthesis through Non-canonical Wnt Signalling pathway.

DBT Project: Transcript profiling and functional significance of molecular determinants of follicular and oocyte competence under metabolic stress

S Nandi, PSP Gupta and S Mondal

The study aimed to examine the total NEFA and ß-OHB composition in serum and follicular fluid of sheep (normal and metabolic stressed). The metabolic stress in the study was due to post-parturient conditions, thermal and transport stress. Metabolic stressors like total non-esterified fatty acid (NEFA, μM), ß-OHB (mM) concentrations were significantly higher in serum and follicular fluid of metabolic stressed ewes compared to control. Measuring NEFA and ß-OHB concentrations can be used as a tool with other factors to help diagnose problems during the metabolic stress. Large preantral follicles are more susceptible to the metabolic stressors compared to the small ones. The increased ammonia caused maximum impairment to preantral follicle growth compared to other stressors.

Oocyte morphology, its fertilizing capacity and granulosa cell functions in ewes (obese, normal, metabolic stressed and emaciated) were assessed. It was observed that the good and fair quality oocytes had greater metabolic activity when collected from normal and obese ewes compared with those from emaciated and metabolically stressed ewes. No significant difference was observed in oocyte quality and maturation amongst the oocytes collected from normal and obese ewes. The cleavage and blastocyst production rates were different for the various body condition classifications and when ranked were found normal > obese > metabolically stressed > emaciated. Lesser metabolic activity was observed in granulosa cells obtained from ovaries of emaciated ewes. However, no changes were observed in viability and cell number of granulosa cells obtained from ewes with the different body condition categories. Estrogen and progesterone production from cultured granulosa cells were not different in normal and obese ewes. Estrogen and progesterone secretions were less from granulosa cells recovered from metabolically stressed and emaciated ewes. The results suggested that oocyte morphology, fertilizing capacity and granulosa cell growth were dependent on body condition and feeding status of the animals.

Incidence of apoptosis, lipid peroxidation and oxidative DNA damage in preantral follicles (PFs) and oocyte-cumulus complexes (COCs) exposed with metabolic stress were assessed. Apoptosis, lipid peroxidation and oxidative DNA damage in PFs and COCs increased with increased dose in the order of ammonia>NEFA> ß-OHB>urea. The three most common NEFA were found in order of stearic acid>palmitic acid>oleic acid. Large PFs were more susceptible to stressors compared to that observed in small PFs.

Relative quantification of mRNA transcripts was performed using qPCR. The levels of ammonia and NEFA which caused significant inhibition on preantral follicle growth and oocyte maturation are being used for gene expression studies. After the RNA extraction and reverse transcription, qPCR was performed to assess the treatment effects on relative amounts of mRNA of candidate genes. BCL2 mRNA was greater in explants treated with 150µM of ammonium chloride compared to explants treated with 0, 100, 200, 250, 300 and 400µM. Similar pattern was observed for IGF1. However, there no changes were observed in BAX expression. DNMT1 and IGF1 expression significantly changes in 250μM and high combo NEFA.

Body condition and feeding status of the animals affect the oocyte morphology and fertilizing capacity. Metabolic stressors caused oocyte and preantral follicle impairment by inducing apoptosis, lipid peroxidation and oxidative DNA damage.

DBT Project: Organic zinc and copper supplementation on advancing puberty, spermatozoal transcription expression profile and fertility in goat

A Arangasamy, IJ Reddy, S Selvaraju, NM Soren and JP Ravindra

Mineral supplements, particularly organic molecule was found to be more efficiently utilized in the body

for optimum productive function than inorganic molecules. In this regard, trace mineral supplementation has been found to be associated with rapid testicular growth, changes in LH secretory pattern, a gradual increase in blood testosterone, initiation of spermatogenesis and to improve the semen quality and fertility. This study was undertaken with the objectives to assess the influence of organic trace mineral enriched diet on early onset of puberty, sexual maturity and circulating hormonal and trace mineral levels; to evaluate the relationship between trace mineral and seminal characters, sperm quality via *in vitro* fertility test, CASA analysis and freezability of buck semen; and to evaluate the effect of altered nutrition on changes in sperm transcriptomic pattern.

Non-descript male goats were procured and acclimatized at the Institute farm. Feeding pattern was standardized on the basis of dry matter intake. The dietary treatments comprising of the following groups: Group 1 (control diet; without trace mineral supplementation); Group 2 to 4 (supplemented with different doses of organic zinc at the level of 20, 40 and 60mg/kg DM respectively); Groups 5 to 7 (supplemented with different doses of organic copper at the level of 12.5, 25 and 37.5mg/kg DM respectively); Groups 8 to 10 (supplemented with the combination of Zn and Cu at the level of Zn 20+Cu 12.5mg/kg DM, Zn 40+Cu 25mg/kg DM and Zn 60+Cu 37.5mg/kg DM respectively). The study was conducted in growing male goats in the age group of 3-5 months for a period of 12 weeks. Blood samples were collected from goats prior to feeding (2 weeks) and during treatment (12 weeks). The testicular biometry (Fig. 24) and body weight of the goats were measured during the trial period. Circulating hormonal levels T3 and T4, IGF-1 were analyzed as per the standard RIA methods.

It was observed that organic zinc and copper had a positive role in growth of testicular biometry and expression of sexual behaviour. Sexual behaviour varied among the experimental groups and it was found to be higher in treatment groups. The expression of sexual behavior found to be related with age, body weight as well scrotal biometry values.

IGF-1 levels were found to increase after 30, 60 and 90d following initiation of mineral supplementation, however the level of increase or decrease in the concentration of IGF-1 depended on individual group and dose of the supplemented mineral. Similarly, levels of T3 and T4 varied between control and treated groups after 30, 60 and 90d following initiation of mineral supplementation.

Fig. 24: Recording of testicular biometry in goat. A: left testicular width; B: scrotal circumference.

Positive roles of organic zinc and copper on testicular biometry and expression of sexual behaviour were evident in goat. The expression of sexual behaviour was influenced by age, body weight as well scrotal biometry values.

Programme 4 Feed Informatics, Feed Quality and Safety and Value Addition

FQS 4.1. Real time estimation of livestock feed and fodder resources availability in India

RK Gorti, KP Suresh, K Giridhar and R Bhatta

Feed and fodder plays an important role in animal production with feed alone constituting more than 60% of the cost of animal products. Hence, it is important to know in advance about the surplus/deficit of feed and fodder resources in different parts of India. At present feed and fodder resources availability projections are being made for the country as whole. This is partly due to the fact that data at micro level is not readily available. Another major problem associated with the process is the actual availability of data in time. India is a vast country with 35 states and union territories comprising 635 districts. Collecting primary data regarding the livestock population and compilation is a huge task. To estimate the feed and fodder requirements for livestock population, the timely availability of livestock census data is a prerequisite. The present system of livestock census enumeration is a time consuming process entailing approximately 2 years. Therefore, real time census data enumeration and compilation would make forecasting of the feed and fodder resources in real time and or in advance. Once a forecast of the requirements is available, it is easy to identify the surplus/deficit areas and movement of the feed resources can be planned accordingly. Advances in the field of information technology have made the real time collection and compilation of data pertaining to livestock feed resources possible.

The objectives of the project were to use of information technology to improve data collection and compilation, estimate feed and fodder resources availability in terms of concentrates, green and dry fodder in all the mandals/taluks of India, and forecast the surplus/deficit at micro level in real time to assist the planners/administrators.

To ensure real time collection and compilation of livestock data, website was designed based on open source software platform (Fig. 25). The website was designed on Java platform using HTML5 standard. It will be a clustered MYSQL DB solution which can be extendable and configurable so that future extension can be done easily. This will enable the use of program across the PC or mobile platform.

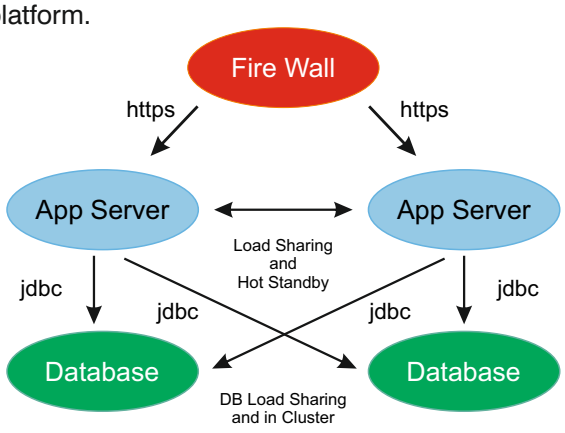


Fig. 25: Design of the database and web application tools for real time collection and compilation of livestock data

A website was designed based on open source software platform for real time collection and compilation of livestock data.

FQS 4.2. Development of a universal inoculum/s for production of quality silage

S Manpal, AV Elangovan, S Senani, AK Samanta, RK Gorti and G Maya

The project aimed to standardize different microbes and enzyme consortia that will boost up the fermentation process of silage within 2 to 3d, minimize loss of nutrients during the fermentation process, reduce the period required for stabilization of silage and provide a set of practical recommendations for the preparation of high quality silage from grasses, fodder crops and crop residues.

Table 9: Gram reaction, morphology and motility of the Lactic Acid Bacteria

Sl.No	Isolate	Gram reaction	Cell morphology	Motility
1	*Lactobacillus plantarum*	+ve	rods	+++
2	*Lactobacillus plantarum*	+ve	curved rods	+++
3	*Lactobacillus brevis*	+ve	bacilli	+++
4	*Pediococcus acidilactici*	+ve	clumped cocci	++
5	*Pediococcus pentosaceus*	+ve	cocci in chains	-
6	*Propionibacterium freudenrichii*	+ve	short rods	+++
7	*Lactobacillus rhamnosus*	+ve	small rods	+++
8	*Leuconostoc mesenteroides*	+ve	cocci	++
9	*Bacillus pumilus*	+ve	rods	+++
10	*Lactococcus lactis*	+ve	cocci	+
11	*Lactobacillus bulgaricus*	+ve	rods	+++
12	*Lactobacillus heliveticus*	+ve	rods	++
13	*Lactobacillus delbrueckii*	+ve	rods	+++
14	*Lactobacillus lactic*	+ve	rods	+++
15	*Lactobacillus pentosus*	+ve	small rods	+++
16	*Streptococcus thermophilus*	+ve	Cocci in chains	-

+++ highly motile, ++ motile, + low motility and - non motile

Sixteen LAB isolates were procured from NCIM and MTCC (Table 9). The procured isolates were inoculated onto lactic acid bacteria growth culture media and pure stocks of cultures were obtained. The culture/colony growth characteristics were observed and noted. Pure working cultures were obtained by repeated culture of the stock culture (Fig. 26) and no change in the colony characteristics were observed. The cultures were gram stained to confirm the gram reaction (cell wall structure) and cell shape microscopically (Table 9). All colonies on plates were observed to be small, smooth, off white to milky white in colour and raised in the centre. Motility was also observed by hanging drop method under the microscope. Gram staining (Fig. 27) and biochemical screening of the cultures were done to exclude non lactic acid producing bacterial.

Differentiation between homo-fermentation and hetero-fermentation of sugars by different isolates was carried out along with the quantification of lactic acid produced in growth media. Different fodder cuts obtained were serially diluted and plated on growth media to obtain different native cultures available on them.

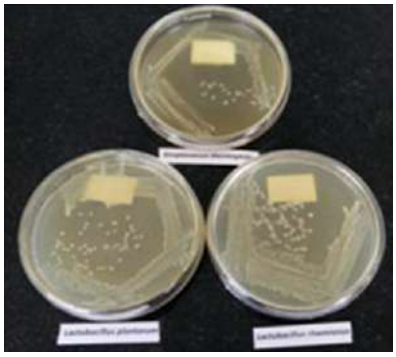


Fig. 26: Growth of pure culture in plates

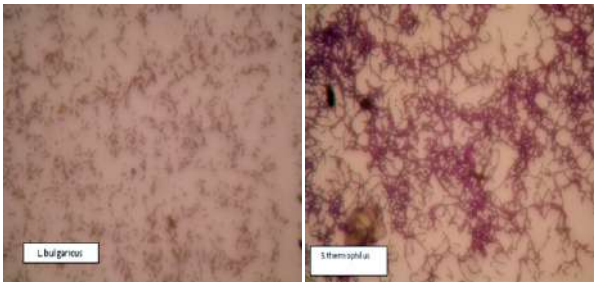


Fig. 27: Gram staining of pure cultures

The lactic acid bacteria for silage making were observed to be small white convex colonies and comprised of gram positive and highly motile rods.

ICAR-CRP Project: Biofortification – evaluation of value addition cereals (vac) and cereal by products for animal feeding

KS Prasad, SBN Rao and NM Soren

Biofortification is one of the methods using advanced plant biotechnological tools to increase a particular nutrient deficient which is in cereals but critical to animal performance. In XII plan, under the leadership of DRR, systematic studies are planned to evaluate the VAC (rice, wheat, maize, sorghum, pearl millet and small millets) developed by various Institutes. ICAR-NIANP, Bangalore is entrusted with the responsibility of quality evaluation of VAC and by-products comparison to their conventional ones in terms of nutrient utilization.

Three biofortified sorghum varieties namely, Phule Rohini (PR), Phule Vasudha (PV) and Phule Revathi (PRev) samples evaluated for chemical composition, mineral contents, *in vitro* gas production, digestibility and fermentation metabolites including individual volatile fatty acids. The CP, EE, TA, NDF, ADF, ADL ranged from 8.19 to 12.8, 2.35 to 2.91, 1.70 to 1.79, 6.67 to 21.1, 3.31 to 6.70 and 0.16 to 0.32%, respectively in three sorghum varieties. The macro minerals P, Mg and Ca ranged from 0.41 to 0.47, 0.14 to 0.15 and 0.01 to 0.02%, respectively and micro minerals Zn, Fe, Mn and Cu ranged from 25.5 to 51.4, 25.8 to 101.3, 8.71 to 15.8 and 0 to 3.35ppm respectively. I*n vitro* gas production was tested to assess 24h gas production, *in vitro* DM and OM digestibility and individual volatile fatty acids production in three sorghum varieties. The 24h gas production (ml/200 mg), TDMD (%) and TDOM (%) in PR, PV and PRev ranged from 53.5 to 63.1, 95.7 to 97.0 and 98.1 to 99.0 respectively. Microbial biomass production (mg/200mg DM) and ME (MJ/kg) ranged from 48.6 to 71.3 and 10.8 to 12.3, respectively in the biofortified sorghum varieties. The concentration of acetate, propionate, butyrate, TVFA and A:P ratio in the incubation media ranged from 40.9 to 44.0mM, 22.7 to 35.3mM, 4.6 to 5.8mM, 69.9 to 84.5mM and 1.2 to 1.8 respectively. The population ($\times 10^5$/ml) of holotrichs, spirotrichs and total protozoa in the 24 h incubated samples ranged from 0 to 0.85, 4.54 to 4.82 and 4.54 to 5.67 respectively.

Three bio-fortified sorghum verities (Phule Rohini, Phule Revathi, Phule Vasudha) were evaluated for chemical composition, mineral contents, in vitro gas production, digestibility and fermentation metabolites including individual volatile fatty acids.

Programme 5 Climate Change Impact on Livestock

3.15. Expression of HSP70 mRNA in visceral organs of broiler chickens under acute heat stress

KS Roy, SC Roy and J Ghosh

The objectives of the study were to detect the localization of HSP70 in visceral organs of broiler birds and to find out the relationship between the expression of HSP70 mRNA and protein.

The level of HSP70 in plasma and tissue samples was estimated by ELISA in different experimental groups. HSP70 level was found variable and gradually increased in 2, 3, 5 and 10h heat exposed tissue lysates of heart, liver and skeletal muscle and plasma as compared to control (Fig. 28). HSP70 level significantly varied in heat treated group as compared to the control, which indicated the potential of HSP70 as a biomarker of heat stress. The plasma level of corticosterone increased as the duration of heat exposure increased until 5h (Fig. 28). The plasma tri-iodothyronine (T3) level decreased significantly during the different hours of heat exposure (Fig. 28). The thyroxin (T4) level followed the same pattern as well, but was not that prominent as compared to T3 (Fig. 28). The results indicated that heat exposure and the level of these hormones had an inversely proportional relationship.

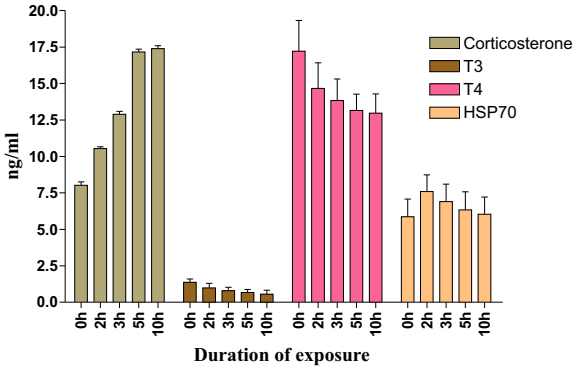


Fig. 28: Plasma level (Mean±SE) of Corticosterone, T3, T4 and HSP70 in different hours of heat exposure (38°C±2; different hours; THI 86±2) and control (Room temperature 26°C±2; THI 69±2) in broiler birds.

The detection and localization of HSP70 were conducted in the tissue samples of brain, liver and skeletal muscle through sensitive chemi-luminescence based Western blot technique in 2, 3, 5 and 10h heat exposed birds. The assessment of HSP70 mRNA expression through qPCR indicated that the expression of the transcript was up-regulated in brain, skeletal muscle, heart, liver and kidney tissues following the heat exposure for 3, 5 and 10h. The comparison and relationship study illustrated that the kinetics of HSP70 expression was both tissue and time dependent, when exposed to thermal stress. The histo-pathological study revealed focal infiltration of mononuclear cells in liver, starry sky appearance with loss of lymphocytes in the lymphoid follicles with reticulum cell hyperplasia in spleen and loss of lymphocytes in thymus in heat exposed birds' samples. However, the kidney, abdominal muscle and brain of the heat stress along with KCl, Vitamin-C and $NaHCO_3$ fed birds showed no observable histological changes when compared to control. The results revealed that heat stress induced pathological changes in liver, spleen and thymus indicating its possible effect on immunity and liver function, which was moderately ameliorated by KCl, Vitamin C or $NaHCO_3$ supplementation with the order of efficacy $NaHCO_3$ < Vitamin C < KCl. However, the combination of these supplements was found more effective than the individual supplementation.

The study suggests that the HSP70 profile in plasma along with plasma corticostreone, T3 and T4 levels can be used as potential biomarkers of stress in poultry birds to adopt proper managmental care for sustaining production.

In broiler chicken, kinetics of HSP70 was found both tissue and time dependent under hyper-thermic state. Histo-pathology study indicated immuno-suppression of birds under heat stress. Supplementation of KCl, Vit-C and NaHCO3 in combination was found most effective to ameliorate stress.

CCL 5.1: Life cycle assessment of green house gas emission from dairy farms of Karnataka State

A Mech, G Letha Devi, M Sivaram and S Sirohi

Life Cycle Assessment (LCA) of GHG emission is an approach that includes all emissions along the supply chain starting from land use, production of feed, emissions from animal production and emissions related to processing and transportation of products to the end users. The LCA for GHG emission from large ruminants and dairy production system was done by FAO (2010, 2013) on global scale based on global livestock environment assessment model (GLEAM). Although these reports contain information on South Asia including India, most of the emission factors used for the analyses under GLEAM are default values applicable to organized livestock sector that are not suitable for the Indian livestock production system. Hence the study was undertaken to conduct life cycle assessment of GHG emission from selected dairy farms of Karnataka State with the objectives to Identify and estimate the major sources of GHG and Develop models for estimating GHG emission from dairy farming.

A questionnaire was developed for survey and data collection. Subsequently preliminary survey and data collection was initiated in the four villages, Janthagondahalli, Shivanahalli, Jaipur Doddi and Begihalli from Anekal Taluk. The dairy farms were categorized into large (>10 cattle), medium (4 to 6 cattle) and small (2 to 3 cattle) dairy farms. The dairy farms were consisted mainly of HF cross bred cows with average milk yield of 9 to 15 litres/head/d. In one small farm, the milk yield was observed as low as 5 litres/head/d due to reoccurrence of mastitis. Most of the cows under survey were between 1st to 3rd lactation. As informed by the farmers', crossbreds cows are retained in the farms until 5th lactation. Machine milking is practiced in all the large dairy farms, whereas in medium and small dairy farms hand milking is practiced. In medium and small farms, 4% of the milk produced is retained for home consumption and remaining milk is sold to cooperatives. In all the farms dung is dumped in open pit or field for approximately six months and then applied to the field. This contributes substantially to the emission of methane. Water usage was recorded as 50 to 70 litres/head/d. By applying IPCC tier II methodology the calculated factor for CH_4 emission from enteric fermentation in dairy HF cross cows was calculated as 93.7 to 100.4 g/head/d. The methane emission from manure management system (MMS) was found to vary between 1.51 to 1.56 g/head/d and nitrogen excretion was found to be between 96.7 to 116.6 g/head/d.

CH_4 emission from enteric fermentation in crossbred dairy cows was found 93.7 to 100.4 g/head/d. From manure management system, CH_4 emission was found 1.51 to 1.56 g/head/d and nitrogen excretion was found 96.7 to 116.6 g/head/d.

ICAR-Outreach Project: Estimation of methane emission under different feeding systems and development of mitigation strategies

Coordinator: R Bhatta

PK Malik and AP Kolte

In vitro studies were conducted in a series to assess the effect of graded levels of tamarind (*Tamarindus indica*) seed husk supplementation on methane production (Fig. 29) and fermentation characteristics. Three levels of tamarind seed husk (2.5, 5.0 and 10.0% of concentrates by replacing wheat bran, w/w) were studied. Results showed a significant ($p<0.05$) reduction in methane production at all the three levels of tamarind seed husk supplementation. However, the methane production among the supplemented groups did not vary significantly. The extent of methane reduction due to tamarind seed husk supplementation at varying levels was found between 22 to 27%. Results revealed a significant ($p<0.05$) reduction in dry matter digestibility of the diet when supplemented with 10% tamarind seed husk. However, the changes in dry matter digestibility at the other two test levels were not different as compared to control diet. Protozoal population among the treatments did not differ significantly.

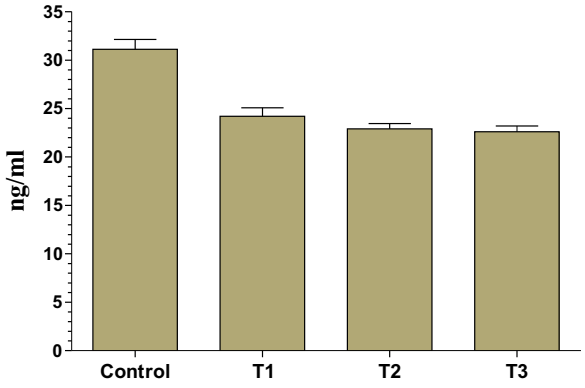


Fig. 29: Effect (Mean±SE) of tamarind seed husk supplementation (T1: 2.5%, T2: 5%, T3: 10% of concentrates) on in vitro methane production.

Based on the *in vitro* studies, two levels (2.5 and 5.0%) of tamarind seed husk were selected for the supplementation in cattle to ascertain the effect on enteric methane emission *in vivo* (Fig. 30). *In vivo* enteric methane emission was recorded highest (106g/d) from the cattle fed on control diet comprising ragi straw and concentrate. Enteric methane emission was decreased ($p<0.05$) with 5% tamarind seed husk supplementation, but the reduction in methane emission at 2.5% level was not found significant.

Fig. 30: In vivo enteric methane emission measurement in cattle

Supplementation of tamarind seed husk at the level of 2.5, 5.0 or 10.0% significantly reduced methane production in vitro. Similarly, 5% tamarind seed husk supplementation significantly reduced methane production in vivo.

ICAR-NASF Project: Deciphering the mechanism of aberrant maternal recognition of pregnancy (MRP) events in sheep and buffalo under heat and nutritional stress

S Mondal, IJ Reddy, S. Nandi and PSP Gupta

Heat and nutritional stresses have been found to alter the maternal uterine micro-environment and thereby affect maternal recognition of pregnancy (MRP) by modulating ovarian, luteal and endometrial function. The present study was undertaken with the objectives to study the effect of heat and nutritional stresses on ovarian function and *in vivo* production of embryos and fertility, delineate the modulation of peripheral endocrine profiles as well as characterization and expressional profiling of genes involved in MRP during heat and nutritional stress, and to study the effect of heat and nutritional stress on gene expression changes during late transition stages of embryonic development.

The quality of the oocytes decreased following heat stress with the incidence of asymmetric shape and cumulous layer dispersed non-differentially as well as fully degenerated oocytes following exposure to 40.5°C (Fig. 31). *In vitro* heat shock at 40.5°C for 18h resulted in shedding of cumulous cells and oocyte degeneration. The maturation rate of oocytes decreased significantly ($p<0.05$) in heat exposed group as compared to that of control. Heat stress significantly ($p<0.05$) decreased protein, glucose, calcium and phosphorus content of matured sheep oocytes *in vitro*. However, heat stress increased ammonia, chloride, SOD and urea contents of sheep oocytes.

Fig. 31: Cumulus layers were non-differentially dispersed after heat stress (A). Fully degenerated oocytes and cumulus cells after heat stress (B).

Similarly, *in vitro* heat shock (40.5°C) resulted in distortion of morphology and degeneration, increased protein, chloride, phosphorus, urea, PGE_2 and $PGF_{2\alpha}$ and decreased calcium, glucose and SOD levels in sheep endometrial epithelial cells. The results indicated that heat stress altered the functions of the cells by modulating its prostaglandins, ionic and metabolic contents. The affect of heat, nutritional and combined stresses on gene expression in sheep endometrium was assessed on day-13 of pregnancy. Heat stress significantly ($p<0.05$) decreased the mRNA expression of COX-II, integrin, FGF2, HSP70, Mx and IGF-1R, but significantly ($p<0.05$) increased the PGFS and iNOS mRNA expression in sheep endometrium. Nutritional stress increased the expression of COX-II, PGFS, Serpin, HSP70, FGF2 and iNOS mRNA, but decreased the PGES, Osteopontin and Mx mRNA in sheep endometrium. The mRNA expression of PGFS and HSP70 significantly ($p<0.05$) increased, but PGES, COX-II, Galactin and Integrin significantly ($p<0.05$) decreased in sheep endometrium in response to combined stress. In buffalo endometrial cells, the expression of PGES, Galactin and Integrin mRNA decreased in response to 12 and 24h exposure to heat stress (40.5°C), but COX-II and PGFS mRNA expression increased in response to heat stress.

The MRP related genes COX-II, PGES, PGFS, Galactin, Integrin, Osteopontin, FGF2 and IGF2 were cloned and characterized in sheep and the nucleotide sequence homology was assessed as compared to the sequences available for other mammalian species.

Supplementation of FGF2 (20ng/ml) and ITS (20ng/ml) alone or in combination in maturation medium was found to increase sheep oocyte maturation, cumulous expansion and embryo cleavage rates as compared to 10 or 30ng/ml of FGF2 or ITS and control. The maturation and cleavage rate of 13, 26 and 39μM BCB+ oocytes was found higher than those in 13, 26 and 39μM BCB- oocytes (Fig. 32). Similarly, the blastocyst development rate of 13 and 26μM BCB+ oocytes was found higher ($p<0.05$) than those in 13 and 26μM BCB- oocytes.

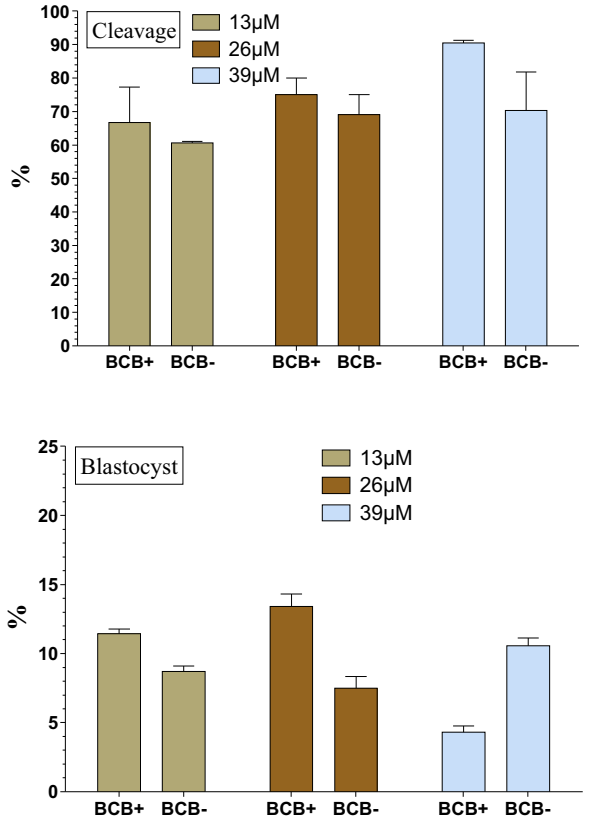


Fig. 32: Cleavage and Blastocyst development rate (Mean±SE) of sheep oocytes following BCB staining

The quality and development of sheep oocytes were found compromised in response to heat stress. Heat stress, nutritional stress and combined stress modulated the expression profile of genes regulating MRP and implantation in sheep endometrium. Supplementation of FGF2 and ITS alone or in combination in maturation media was found beneficial for sheep oocyte and embryo development.

DBT Project: Livestock methane reduction through immunization based approach

PK Malik, R Bhatta, AP Kolte, S Manpal and A Dhali

One attractive and novel option for reducing the methane emissions from ruminants may be the immunization of animal system against their own methanogens. At this context, the project was undertaken with objectives to perform diversity

analysis and quantitation of rumen *archaea* through molecular approaches, formulate species specific vaccine(s) for the active immunization of cattle and buffaloes, and to evaluate the effect of active immunization and secondary metabolites combo preparation on *in vivo* methane emission and fermentability pattern.

A series of *in vitro* studies were conducted to optimize the levels of inclusion of different plant secondary metabolites such as condensed tannin (CT), hydrolysable tannin (HT), saponins, combination of CT and HT, combination of tannins (CT+HT) and saponins, essential oils etc., for formulating the combo preparation of secondary metabolites to ameliorate methane emission. The results revealed no significant change in methane production as well as feed fermentability when CT was supplemented (Fig. 33) at low levels (0, 8, 16 and 24mg/g). Supplementation of CT from *Mimosa pudica* at moderate levels (30, 40 and 60mg/g) revealed significant ($p<0.05$) reduction in methane production in the range of 21 to 31% as compared to control diet. There was no significant reduction in dry matter digestibility with moderate levels of supplementation.

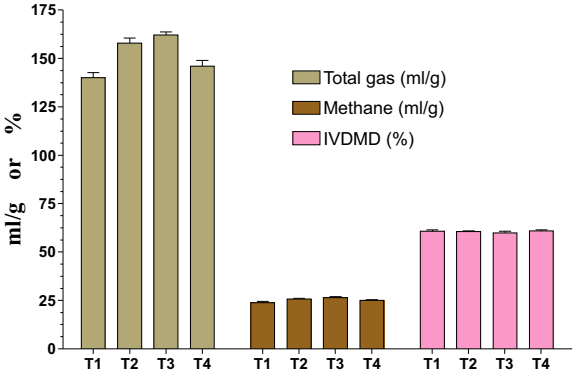


Fig. 33: Effect (Mean±SE) of low levels of condensed tannins (T1: 0mg/g, T2: 8mg/g, T3: 16mg/g, T4: 24mg/g) on total gas and methane production (ml/g) and IVDMD (%)

Studies conducted with HT did not reveal any significant changes in methane production as well as feed fermentability with low levels of HT (0 to 20mg/g). Like CT, Supplementation of HT at moderate levels (30 to 60mg/g) revealed significant ($p<0.05$) reduction in methane production in the range of 29 to 53% as compared to control. Based on the *in vitro* studies with CT and HT, 30 mg/g level was selected for the supplementation in finger millet and concentrate based diet. CT and HT were mixed in 1:1 ratio and combo of both was evaluated at different graded levels from 30 to 60mg/g substrate. The results revealed 27% reduction in methane production with a combo of CT and HT at 30mg/g supplementation. However, further reduction in methane production at higher levels was also observed, but with a concurrent decrease in dry matter digestibility. A significant ($p<0.05$) reduction in methane production was evident, when saponins was added at varying levels from 5 to 40mg/g of substrate. Approximately 22 to 27% reduction was achieved with graded levels of saponins and reduction at lowest level (5mg/g) did not differ with other levels of supplementation. The findings of the *in vitro* studies indicated that the supplementation of saponins at lowest level (5mg/g) with a combo of CT+HT (30 mg/g, 1:1) was more effective for *in vitro* methane reduction than using them alone (Fig. 34)

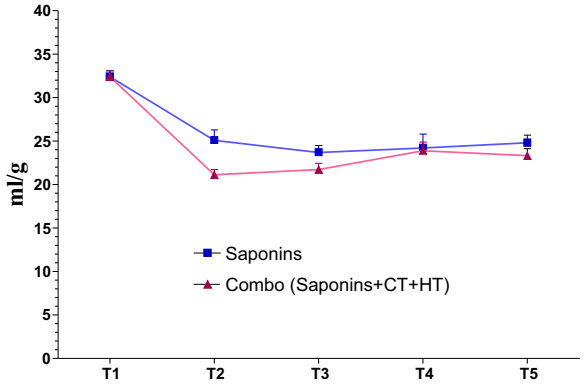


Fig. 34: Comparative efficacy (Mean±SE) of saponins (T1: 0mg/g, T2: 5mg/g, T3: 10mg/g, T4: 15mg/g, T5: 20mg/g) and combo (saponins: 0, 5, 10, 15 and 20mg/g + tannin: 30mg/g, CT:HT=1:1) on methane production (ml/g)

Supplementation of CT and HT at moderate levels (30mg/g) significantly reduced methane production without altering digestibility in vitro. Similarly, supplementation of saponins at low level (5mg/g) significantly reduced methane production in vitro. Further, supplementation of the combination of saponins, CT and HT was found most effective than individual supplementation in reducing methane production in vitro.

DST-JSPS Project: Methane mitigation using unexplored phyto-sources in ruminants and their effect on rumen microbial diversity

R Bhatta, AP Kolte and PK Malik

This joint Indo-Japan project was undertaken with the objective to ameliorate enteric methane emission from livestock, evaluate various phyto-sources from natural plants and food industrial byproducts for inhibiting methane emission from ruminants and to elucidate responses of the microbial communities inhabiting the rumen of adult ruminants and comparing kinetic differences of nutrients digestion.

Sixteen plant samples were collected from the *Himalayan* region (Nainital district, Uttarakhand) and air dried before bringing to the Institute for further *in vitro* analysis to explore their potential for methane reduction. *In vitro* studies with two sources (A and B) incorporated in the concentrate at 0, 5, 10, 15, 20 and 22% levels replacing wheat bran on equal mass basis, were conducted in laboratory. Preliminary results from two different sources revealed variable impact on methane production. Source A was ineffective in terms of methane reduction, while source B showed linear reduction in methane production. The evaluation of other sources for methane amelioration through continuous *in vitro* incubation is in progress. Scientists from collaborating Institutes in Japan (NILGS, Tsukuba and Shinshu University, Nagano) visited India and reviewed the work progress. Indian scientists also visited NILGS, Tsukuba and Shinshu University to review the progress.

The joint Indo-Japan project was initiated to assess the potential of phyto-sources from natural plants and food industrial byproducts to reduce enteric methane emission from ruminants.

Programme 6 Technology Translation to Connect Discovery with Application

TTA 6.1: Socio-economic impact of area specific mineral mixture technology in Karnataka

T Chandrappa , G Letha Devi and S Jash

The project aimed to assess the adoption pattern of ASMM technology in Karnataka, study the impact of ASMM technology on production and profitability of dairy farming and to document the farmers' perceptions of the ASMM technology.

Secondary data was collected from Karnataka Cooperative Milk Producers Federation (KMF), Bengaluru, Karnataka State District Milk Unions, village milk co-operative societies and other agencies on various aspects like ASMM production, distribution and pricing etc. Based on the secondary data, the study-districts were identified and selected in different regions. The sample size was 320 covering 16 villages and 8 taluks in 4 regions. Primary data were collected from Hassan, Bangalore rural and Dharwad districts by using pre-tested questionnaires on identified and selected socio-economic variables. Master chart for data tabulation and classification was prepared. From the secondary data, it was evident that the annual production of area specific mineral mixture by KMF increased between 2007 and 2015 in Karnataka.

The project was initiated to assess the socio-economic impacts of the technology Area Specific Mineral Mixture. Primary and secondary data were collected for the assessment.

ARChE_Net Project: Regional network for skills exchanges on dynamic adaptation of ruminant production systems to a changing environment

PSP Gupta, K Giridhar and S Jash

This project was initiated and promoted by the Centre of International Cooperation in Agronomic Research for Development (CIRAD), Re Union Island, France for the effective collaboration of Indian Ocean rim countries (Australia, India, Madagascar, Mozambique, Reunion (France), South Africa and Union of Comoros) for skills exchanges on dynamic adaptation of ruminant production systems to a changing environment. From India, three institutions ICAR-NIANP, Bengaluru, Veterinary College, Hyderabad and BAIF, Pune had participated in the project.

Under the project, hybrid-napier-bajra and hybrid napier fodder samples were collected from various places of Karnataka and spectral data of the samples were generated using a portable Near-infrared Spectroscopy (NIRS) machine. A few samples were reanalyzed for wet chemistry. The software “unscrambler, version 10.3” was used for the analysis of spectral data.

Trainings were also conducted under the project. Two training cum workshop were conducted at BAIF, Pune ICAR-NIANP, Bengaluru. Another training program on LASER SOFTWARE (a Support Software for Monitoring Ruminant Production) was organized at NIANP, Bangalore. The LASER software facilitates the management and analysis of demographic, zoo-technical and epidemiological data, identified at the single animal scale within ruminant herds. This is highly useful while collecting repeated data from a group of animals in the field condition for nutritional, reproduction or epidemiological studies.

Near-infrared Spectroscopy was found to be an effective tool to assess the fodder quality. Training on Near-infrared Spectroscopy and LASER software was imparted to the faculty of Veterinary Colleges, Local ICAR Institutes and BAIF, Pune.

ICAR-Extramural Project: Need assessment, development and evaluation of web based livestock advisory and information system

G Letha Devi , A Mech, S Senani and M Kumar

Indian livestock farmers face challenges in accessing information and services via digital tools that are crucial for decision-making. Structuring scattered information in searchable interactive system, delivery by proper channel and creating trustworthiness of data are major challenges. A multi linguistic web based livestock advisory and information system may help to address these issues. Such a web based system would cater as one stop source of information delivery to end users like livestock farmers, students, veterinarians, scientists, policy makers and livestock industries. The project was framed with the objectives to assess and map farmer capability, awareness and preparedness about IT tools for livestock farming, design and development of a multi linguistic web based livestock advisory and information system for delivery of information to end users, and to test and evaluate the developed web based Livestock Advisory and Information system.

The project was initiated to develop a multi linguistic web based livestock advisory and information system as one stop source of information delivery to end users.

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Lead papers/ Oral presentations

Adhiguru P and Letha Devi G. Attracting youth for agripreneurship: policy perspectives. In: Souvenir of the National Youth Convention, ICAR, New Delhi on 27 January, 2016. pp23-25.

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Bhatta R, Malik PK and Sejian V. Livestock and climate change: interlinking and measures to counter adverse impact. 7th Kerala Veterinary Science Congress, Pookode, Wayanad, 14-15 November 2015. pp53-68.

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Sridhar M, Samanta AK and Senani S. Microbial deconstruction of lignocellulosic materials for feeding to livestock : Current Trends and Future Prospects. XVI Biennial Conference on the theme "Innovative Approaches for Animal Feeding and Nutritional Research", ICAR-NDRI, Karnal, 6-8 February 2016, pp141-153.

Invited lectures

S Manpal

Biotechnological applications of microbial enzymes with reference to lignolytic enzymes of the Basidiomycota. Lecture delivered in National Conference on "New Approaches and Concepts in Microbial Biotechnology - 2015", Department of Microbiology, Maharani's Science College for Women, Bengaluru, 29-30 September, 2015.

RS Umaya

Phytoproducts as novel protective substances against Aspergillus fungi and aflatoxin in poultry. Lecture delivered in the 5th Women's Science Congress on "Science and Technology for Indigenous Development of Women In India", Indian Science Congress 2016, University of Mysuru, Karnataka, 4-6 January, 2016.

PK Malik

Presented research activities of climate change group of ICAR-NIANP during "Knowledge Sharing Workshop on Climate Change", organized by Environmental Management & Policy Research Institute (EMPRI), Hotel Capitol, Bengaluru, 29 March, 2016.

J Ghosh

Revealing functional biology by high throughput techniques. Lecture delivered during workshop on "Emerging trends in biotechnology and its future prospects" organized by Karnataka Science and Technology Academy, Govt of Karnataka and Center for Post graduate studies, Jain University, Bengaluru, 5-6 February, 2016.

PSP Gupta

Application of in vitro cell culture in livestock sector. Guest lecture delivered at Faculty Development Program Workshop held by Department of Biotechnology/ Biotechnology Finishing School (BTFS), The Oxford College of Sciences, Bengaluru, 6 July, 2015.

Recent trends in Reproductive Biotechnology in Farm Animals. Lecture delivered at Garden City College, Bengaluru, 25 August, 2015.

V Sejian

Climate change and experimental trials on animal production: Design, analysis and adaptation strategies. In: ICAR sponsored Summer School on "Principles and concepts of livestock disease informatics and modeling in veterinary epidemiology conducted at ICAR-National Institute of Veterinary Epidemiology and Disease Informatics, Bengaluru on 26 June, 2015.

Evaluating the Role of Animal Husbandry in Climate Resilience and Adaptation. Lecture delivered during the state level training programme for climate change working group members and other state officials of Madhya Pradesh at Bhopal, 22 April, 2015.

K Giridhar

Better agro-techniques for forage production. At the workshop on livestock feeding and fodder development at KVK, Davanagere, 10 August, 2015.

Improved green fodder production and conservation. At the workshop on 'Balanced feeding and improvement of green fodder production' at Dairy cooperative society, Balenahalli, Tumkur district, 10 March, 2016.

Fodder production and conservation' at the 7th Agrovision conference on dairy management at Nagpur. 14 December, 2015.

Improved varieties of fodder crops for Coastal Karnataka at the workshop on improved dairy farming at Puttur, Dakshina Kannada, 1 January, 2016.

AP Kolte

Bioinformatics as diagnostic tool for microbial diseases. At the national workshop on "Diagnostic approaches for zoonotic diseases" under Niche Area of Excellence Programme on Centre For Zoonoses at Nagpur Veterinary College, Nagpur, 16 February, 2016.

Bioinformatics tools for identification and characterization of bacteria. At the DBT sponsored national workshop on "Molecular subtyping of microbes using Pulsed Field Gel Electrophoresis at Nagpur Veterinary College, Nagpur, 9 September, 2015.

Metagenomics: an introduction and key considerations. At the winter school on Analysis of High Throughput Sequencing and Microarray data to Unravel Host-Pathogen Interactions. At Division of Veterinary Biotechnology, IVRI, Izatnagar, 21 November, 2015.

Application of transcriptomics in stress research. At the winter school on Analysis of High Throughput Sequencing and Microarray data to Unravel Host-Pathogen Interactions. At Division of Veterinary Biotechnology, IVAR, Izatnagar, 21 November, 2015.

AK Samanta

Prebiotics and gut health in animals. At the Advanced Short Course Clinical Nutrition Approaches for Gut Health of animals at ICAR-Indian Veterinary Research Institute, Bareilly, 11 March, 2016.

Application of T-RFLP analysis in gut health research. At the Advanced Short Course Clinical Nutrition Approaches for Gut Health of animals at ICAR-Indian Veterinary Research Institute, Bareilly, 11 March, 2016

NKS Gowda

Mineral status in different agro-eco zones of India : Its implications and amelioration in livestock. At the short course on Micronutrients in Animal Nutrition at Centre of Advanced Faculty Training in Animal Nutrition at IVRI, Izatnagar, 3-23 February 2016.

Mineral utilization and strategies for reduced excretion- An environmental perspective. At the short course on Micronutrients in Animal Nutrition at Centre of Advanced Faculty Training in Animal Nutrition at IVRI, Izatnagar, 3-23 February 2016.

S Selvaraju

The enigma of male fertility assessment: concepts and advances. At the ICAR Sponsored Winter School on, "Advances in breeding and infertility management in canines", Madras Veterinary College, Chennai, 12 November - 2 December, 2015.

Sperm transcriptome sequencing for predicting bull fertility: Lessons learnt. At the ICAR sponsored winter school on Current concepts and frontier technologies for fertility management in farm animals from at ICAR-NDRI, Karnal, 5-25 October, 2015.

Semen quality and dairy cow fertility. At the short course on Current Concepts and Recent Developments in Dairy Cattle Feeding and Fodder Production. Department of Animal Nutrition, Veterinary College and Research Institute, Namakkal, 14-21 December 2015.

Metabolic hormones: influence on gonadal functions and fertility in livestock. At the ICAR sponsored winter school on Current concepts and frontier technologies for fertility management in farm animals at ICAR-NDRI, Karnal, 5-25 October, 2015.

Lecture notes

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Malik PK, Bhatta R and Sejian V. Alternate H2 Sinks for Reducing Rumen Methanogenesis. pp45-51.

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Sejian V, Bhatta R, Malik PK, Bagath M, Soren NM, Abdul Niyas PA, Shaji S, Sophia I and Chaidanya K. Salient adaptation, mitigation and amelioration strategies to improve livestock production under the changing climatic scenario. pp75-88.

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Compendium of International Training Programme on "Livestock methane and climate change: Recent advances in methane estimation & amelioration strategies" sponsored by FAO, New Zealand Agricultural Green House Gas Research Centre, ICAR-NIANP, from 11-20 August, 2015 at NIANP, Bengaluru

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Parthipan S, Shilpa M and Selvaraju S. Protocol for relative quantification of transcripts in bull spermatozoa. pp175-178.

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Media

The Director, Raghavendra Bhatta gave an interview to France-based website feednavigator.com on "Tackling methane emissions in dairy herds in Asia and Africa" on 14 April, 2015.

K Giridhar delivered a talk on 'Importance of fodder tree leaves for livestock feeding' on 22 April, 2015, AIR, Bengaluru.

NKS Gowda delivered a talk on "Clean milk production and milk quality" on 5 November, 2015, AIR, Bengaluru.

Awards and honours

M Chandrasekharaiah

Fellow of Animal Nutrition Society of India (FANSI), 2016.

V Sejian

Endeavour Research Fellowship of the Australian Government to pursue post doctoral research for six months (24 August, 2015 to 24 February, 2016) at The School of Agriculture and Food Sciences, The University of Queensland, Gatton, Queensland, Australia.

DN Mullick Memorial Award for the outstanding contribution in the field of Animal Physiology by Society of Animal Physiologists in India (SAPI) during the Annual conference of SAPI held at Guwahati, Assam, India on 21 January, 2016.

Conference Awards

Conferences	Awards
XVI Biennial Animal Nutrition Conference on 'Innovative Approaches for Animal Feeding and Nutritional Research', 6-8 February, 2016, Karnal.	Second oral presentation award for '*In vitro* efficacy of lignin peroxidases obtained from white rot fungi in enhancing the digestibility of crop residues for feeding ruminants'. Vandana T, Ramya GR, Samanta AK, Senani S and Manpal S. Second oral presentation award for "Nutritional evaluation of different Ayurvedic medicinal residues as livestock feed" Dominic G, Prasad KS, Soren NM, Rao SBN and Swain PS. Best Poster award for 'Strategic Limiting Nutrient Supplements for Improved Milk Production Performance in Crossbred Cows-On Farm Trial' Chandrasekharaiah M, Rao SBN, Soren NM, Reddy IJ, Dominic G and Thulasi A. Best poster award for 'Production of chitooligomers from shrimp waste and its effect on pathogenic organisms'. Varun TK, Senani S, Samanta AK, Kumar N, Paswan JK, Satpathi D, Gautam M and Sharma A.
National Seminar on "Harmonizing biodiversity and climate change: Challenges and Opportunity", 17-19 April, 2015, ICAR-CIARI, Port Blair, A&N Islands.	Best Paper Award for "Livestock production adapting to climate change". Sejian V, Bhatta R, Malik PK and Bagath M.

International Symposium on 'Microbiome in Health and Disease (MICROHD2016)', 23-25 February, 2016, ICAR-NIANP, Bengaluru.	First prize for the poster "Identification and abundance of antimicrobial transcripts in spermatozoa and their relationship with field fertility in bovine (*Bos taurus*)". Parthipan S, Selvaraju S, Somashekar L, Kolte AP, Arangasamy A and Ravindra, JP. First prize for the poster 'Ameliorative effect of chromium enriched azolla as feed supplement for laying chickens recovering from new castle disease' Rajendran D and Arangasamy A. Second prize for the poster 'Enteric methane amelioration through graded supplementation of tamarind Seed Husk (*Tamarindus indica*) in finger millet based complete feed block'. Malik PK, Kolte AP, Dhali A, Bakshi B, Baruah L and Bhatta R. Second prize for the poster "Immne-regulatory protein profile of buffalo spermatozoa and its association with male fertility". Archana S, Binsila BK, Somashekar L, Selvaraju S and Ravindra, JP. Second prize for the poster "Terminal restriction fragment length polymorphism analysis of fecal microflora of finisher pigs supplemented with plant sourced feed additives" Samanta AK, Jayaram C, Kolte AP, Dhali A, Senani S, Sridhar M and Roy S.
XXIV Annual conference of SAPI and National Symposium on "Physiological Approaches for Development of Climate Resilient Livestock Farming", 21-22 January, 2016, AAU, Guwahati.	Best oral presentation award for "L-Carnitine mediated alteration in expression pattern of apoptotic genes in sheep oocytes and developing embryos produced *in vitro)*. Mishra A. Best oral presentation award for "Effect of different wave lengths of light on broiler chicken production". Reddy IJ. Best oral presentation award for "Effect of in vitro supplementation of copper on granulosa cells estradiol synthesis and associated genes". Gupta PSP.
XXX Annual convention and National Symposium of Indian Association of Veterinary Anatomists, 16-18 December, 2015, Kolkata.	Dr AK Srivastava Award for the paper 'Existance of Immune modulation in porcine placenta'. Rajani CV, Prasad RV, Jamuna KV, Ravindra JP, Parthipan S, Pushparani G and Selvaraju S.
XXXI Annual Convention of the ISSAR, 3-5 December, 2015, Veterinary College, Bengaluru	First Prize for the poster 'Influence of IGF-1 on buffalo spermatozoa function and comprehensive protein profiles of post-thaw semen'. Archana SS, Binsila BK, Somashekar L, Karthik Bhat, Selvaraju S and Ravindra JP. First Prize for the poster 'Seminal plasma RNAs transcript expression profile and its relation with seminal quality in bulls'. Shilpa M, Grish kumar V, Selvaraju S, Parthipan S and Arangasamy A.
8th GCRA International Conference on "Innovative Digital Applications for Sustainable Development", 5-7 January 2016, UAS Bengaluru	Best oral presentation award for the paper "Feed Assist: Expert System for computing least cost balanced ration". Letha Devi G.
3rd Biennial Conference of Indian Academy of Veterinary Nutrition and Animal Health held from November 4th to 5th, 2015 at CSK HPKV, Palampur.	Second best poster award for 'Comparison of proximate composition, yield of chitin and chitosan from different part of shrimp shell waste'. Varun TK, Senani S, Kumar N, Paswan JK, Satpathi D, Gautam M, Sharma A and Thirumulaisami G.

Training & Capacity Building

Training/Workshop organized

International Training Program on "Livestock methane and climate change: recent advances in methane estimation and amelioration strategies" for the researchers from SAARC countries and African Union, 11-20 August, 2015

The international training programme on "Livestock methane and climate change: recent advances in methane estimation and amelioration strategies" for the SAARC countries and African Union was organized during the period of 11-20 August, 2015. The Food and Agricultural Organization of the United Nations (FAO) and Livestock Research Group (LRG) of the Global Research Alliance (GRA), New Zealand Government extended technical support for conducting the training programme. Participants from South Africa, Ghana, Nepal and India attended the training. During the training, several international faculties interacted with the participants. Dr Patrick R Zimmerman, President C-Lock Inc, South Dakota, USA, introduced the "Greenfeed", an on field portable real time methane emission estimation device for assessment of methane emissions from livestock. Dr HPS Makkar, Animal Production and Health Division, FAO, Rome, Italy delivered lectures on methanogenesis in rumen, its estimation and amelioration strategies through nutritional interventions. Dr Harry Clark, Director, New Zealand Agricultural Greenhouse Gas Research Centre explained about the modelling approaches for developing national inventories to monitor the livestock generated methane emissions. Dr Yutaka Uyeno, Shinshu University, Japan delivered a lecture on the use of phytochemicals in ameliorating the methane emissions from livestock enteric fermentation. In addition, the scientists from the Institute delivered various theory and conducted practical classes which covered enteric methane emission, its estimation and amelioration strategies, life cycle analysis of green house gas emission from animal production system, livestock stress management and application of molecular tools for assessing the diversity of methanogenic archaea and other rumen microbes.

ICAR sponsored winter school on "Livestock and climate change: challenges and ways ahead for sustainable production", 1-21 October, 2015

The ICAR sponsored 21-day winter school on "Livestock and climate change: challenges and ways ahead for sustainable production" was organized during the period of 1-21 October, 2015. The winter school was attended by 25 participants from 13 different states of the Country. During the training programme, a total of 38 theory classes and 16 practical demonstrations were offered. Various thematic areas that were covered during the training were vulnerability of different agro-climatic regions for climatic stress; impact of climate change on feed quality, availability and future projections; impact of climate change on male and female reproduction; molecular and metagenomic approaches for diversity analysis of rumen/gut microbiome; monitoring enteric methane emission and its mitigation; and life cycle analysis of green house gas emissions from animal sector.

ICAR sponsored short course on "Recent concepts in bull fertility assessment and quality semen production for improving fertility in farm animals", 14-23 September, 2015

The ICAR sponsored short course on "Recent concepts in bull fertility assessment and quality semen production for improving fertility in farm animals" was organized during 14-23 September, 2015. Twelve participants from different states participated. During the course, various aspects on bull fertility assessments such as bull selection, semen evaluation-conventional and advanced tests including DNA quality assessment, seminal proteome assessment, hormone estimation, *in vitro* fertility test and ultrasonographic evaluation of male reproductive system were covered. The participants were also exposed to the cryopreservation procedures and additives for maintaining sperm fertilizing potential. Emphasis was given on the factors including stress and environmental contaminants affecting conception rates, importance of fixed time breeding, early embryonic mortality, early pregnancy diagnosis and nutritional management of bull and cows.

Industrial experience training on "Climate change and livestock production", 8-28 June, 2015

An Industrial experience and training as a part of elective courses in veterinary and animal sciences stream of KAU students on "Climate change and livestock production" was conducted from 8-28 June, 2015. An orientation program was arranged to give details of the Institute activities. The students were explained about the training program. They were given equal exposure to both theory and practical classes on "Climate change and Livestock Production". The students were taught in detail on two broader areas, livestock contribution to climate change and the impact of climate change on livestock production.

Hands on Training on "SF6 tracer technique for measuring *in vivo* methane emission from ruminants", 20-22 July, 2015

A Hands on Training on "SF6 tracer technique for measuring *in vivo* methane emission from

ruminants" for the Principal Investigators and Co-Investigators from the participating centres under the Outreach Project on "Estimation of methane emission under different feeding systems and development of mitigation strategies" was organized during the period of 20-22 July, 2015. Nine participants attended the training and learned the technique for *in vivo* methane estimation.

Workshop on "Use of near infrared spectrometry (NIRS)", 30 April, 2015

A workshop on "Use of Near Infrared Spectrometry (NIRS) for evaluation of forage quality" was organized under the international collaborative ARChE_Net project on 30 April, 2015. The workshop was organized for the benefit of the scientists, research fellows and students and it highlighted the importance of NIRS in the quality assessment of animal feeds. The scientists, who received training abroad in the area, shared their experiences regarding the use of NIRS for estimating the quality of different forages and silages. A live demonstration on the use of NIRS for estimating forage quality was also organized.

Official Language training programme cum workshop for the staff of the ICAR Institutes located in Bengaluru, 21-23 March, 2016

An "Official Language training programme cum workshop" was organized for the staff of the ICAR Institutes located in Bengaluru during the period of 21-23 March, 2016. The training was attended by 30 participants from various Institutes such as ICAR-NIVEDI, ICAR-SRS-NDRI, ICAR-CIFRI, ICAR-NBSSLUP, ICAR-NBAIR and ICAR-NIANP. Shri Charles Ekka, SAO, ICAR-NIANP and Shri AK Jagadeesan, AD(OL), ICAR-IIHR were the faculty members for the training programme. A wide range of topic such as official language policy and implementation, scientific writing in Hindi, E-tools in Official Language implementation, forms and procedure of communication in Hindi, records management, security of official information and documents, noting and drafting in Hindi and checks on delays and inspection were covered during the programme.

Computer training for the skilled supporting staff, 14-16 March, 2016

An in-house computer training was conducted for the skilled supporting staff (SSS) of the Institute during the period of 14-16 March, 2016. The training programme aimed to create computer awareness among the skilled supporting staff and four employees participated in the training. Emphasis was given on various parts of computers and how to handle them. Participants were trained from the preliminary aspect of proper switching on to shutting down a terminal. They were also taught how to create a new folder, delete a folder, access folder,

open and to create documents in it etc. Preliminary typing aspect was also covered. As they were required to check their salary slips online, special emphasis was given to open their respective salary slip and to give print command. All the participants were provided with an individual training manual. They were also trained to access the ICAR, ICAR-NIANP and other important websites.

Stakeholders' meeting

Meeting on 'Refinement of database model on feed and fodder availability in India

A meeting on 'Refinement of database model on feed and fodder availability in India' was held on 30 October, 2015 at the Institute. The senior officials from Central Statistical Organization, ICAR-NDRI, ICAR-NIANP, NDDB and ICAR-IGFRI attended the meeting. Dr Raghavendra Bhatta, Director, ICAR-NIANP briefed about the salient points from the previous meeting organized by ICAR and NDDB at NASC complex New Delhi on 8 June, 2015. Dr BG Shivakumar, Head, ICAR-SRS-IGFRI, Dharwad made a presentation on the database work done at ICAR-IGFRI, Jhansi. The participants requested ICAR-IGFRI to share the complete details of methodology adopted for the database work. Sri Sahu, DDG (statistics) from CSO, MOSPI, New Delhi presented the details of Timely Reporting of Statistics (TRS) and General Crop Estimation Survey (GCES) schemes of Govt of India for estimation of crop acreage and production. Dr BM Bhanderi from NDDB gave the details of unconventional feed resources and livestock feeding practices from various parts of the country and the work conducted under the ration-balancing-programme. Dr Amrish Tyagi, HOD, DCN division, ICAR-NDRI made a presentation on the database work done at Karnal. Dr Dinesh Bhosale from AB vista gave the perspective of feed manufacturers and the future scenario for quality feed production in India. Dr KS Ramachandra, I/c HOD (AND), ICAR-NIANP mentioned that as development of database on feed and fodder availability in India is a complex issue, all the major agencies should take a holistic approach and harmonize their data and results so that unified figures of fodder availability can be generated on a pragmatic basis.

Human resource development

Three month attachment training programme for the newly recruited ARS scientists

Name of the Trainee	Parent Institute	Duration of attachment training at ICAR NIANP	Mentor
Dr GV Vedamurthy	ICAR-CSWRI, Avikanagar, Rajasthan	1 June to 31 August, 2015	PSP Gupta
Dr Sophia Inbaraj	ICAR-CIARI, Portblair, Andaman and Nicobal Island	10 May 1to 10 August, 2015	V Sejian
Dr Manoj Kumar Tripathi	ICAR-CIRB, Hisar, Haryana	1 June to 31 August, 2015	S Mondal

Support extended to the scholars for conducting research with external grants

Scholar	Title of the research project	Grant	Mentor
S Roy	Biotransformation of D-galactose into D-tagatose and its evaluation as Nutraceuticals	DST Women Scientist A	AK Samanta
K Sangeetha	Maintaining stemness of mesenchymal stem cells (MSC) on the supplementation of a novel asymmetric cell kinetic inhibitor	DST Women Scientist A	J Ghosh
G Pushpa Rani	Arsenic-induced reproductive and metabolic toxicity in mice: protective role of phyto chemicals	UGC-women Post Doc Fellow	JP Ravindra
L Somashekar	Assessing bull fertility based on seminal and sperm membrane proteins	DST-INSPIRE Fellow	JP Ravindra

Training undergone by staff

Scientists

National

Particulars	Participants
Official Language training programme cum workshop for the staff of the ICAR Institutes located in Bengaluru, 21-23 March, 2016, ICAR-NIANP, Bengaluru	A Arangasamy, A Mech, BK Binsila D Rajendran, M Bagath, NM Soren, RU Umaya, S Selvaraju
Application of statistical techniques in biological research, 2-4 March, 2016, ICAR-SRS-NDRI, Bengaluru	A Mech , A Mishra, PK Malik
Refresher course on animal research management, 13-25 July, 2015, ICAR-NAARM, Hyderabad	A Mishra
Priority setting, monitoring and evaluation, 2-6 June, 2015, ICAR-NAARM, Hyderabad	DT Pal
Competency development for HRD nodal officers of ICAR, 10-12 February, 2016 , ICAR-NAARM, Hyderabad	AV Elangovan
State level training programme for climate change working group members and other state officials of Madhya Pradesh, 22 April 2015, Bhopal	V Sejian
User's training workshop on ICAR -Krish Geoportal , 28-30 March, 2016, ICAR-NBSSLUP, Nagpur	D Rajendran

International

Particulars	Participants
Six month post doctoral research (24 August, 2015 - 24 February, 2016) on "Impact of chronic heat stress on metabolic and inflammatory response in feedlot cattle" at The School of Agriculture and Food Sciences, The University of Queensland, Gatton Campus, Queensland, Australia supported by the 'Endeavour Research Fellowship' of the Australian Government.	V Sejian

Technical personnel

Particulars	Participants
Training on SAS, 25-30 May, 2015, ICAR-NIVEDI, Bengaluru	G Maya
Official Language training programme cum workshop for the staff of the ICAR Institutes located in Bengaluru, 21-23 March, 2016, ICAR-NIANP, Bengaluru	G Maya
Training on electrical maintenance and safety, 31August - 11 September, 2015, Foreman Training Institute, Bengaluru	KM Kamalesh

Administrative personnel

Particulars	Participants
Training on public procurement, 20-25 April, 2015, NIFM, Faridabad	S Athimoolam
Training on pay fixation, 18-20 November, 2015, ISTM, New Delhi	A Murthy
Official Language training programme cum workshop for the staff of the ICAR Institutes located in Bengaluru, 21-23 March, 2016, ICAR-NIANP, Bengaluru	A Murthy, A Neil Vincer, R Kalaivani

Skilled supporting staff

Particulars	Participants
Computer application training for the skilled supporting staff, 14-16 March, 2016, ICAR-NIANP, Bengaluru	Chennamaraiah, J Lakshmi, K Narayana, Ningamma

Meeting/ Conference/ Symposium attended by the Director

Particulars	Date
Attended Interactive Meeting with Honourable Union Minister for Agriculture, Shri Radha Mohan Singh	2 April, 2015
Attended Annual Review meetings of AICRP and Outreach projects, under the chairmanship of DDG (AS), ICAR, Bikaner	17-18 April, 2015
Attended Review Meeting under the chairmanship of DDG (AS), ICAR to consider retention of staff on attaining the age of 58 years, New Delhi	13 May, 2015
Attended One-day workshop on “Optimization of fodder research for increasing milk production”, organized by ICAR-IGFRI, NDDB and DADF, Ministry of Agriculture, Govt of India, New Delhi	8 June, 2015
Attended lecture programme delivered by the DG, ICAR on “Food for India - 2050”, UAS, Bengaluru	13 June, 2015
Attended Seventh meeting of Global Research Alliance Livestock Research Group, Lodi, Italy	23-24 June, 2015
Attended Joint LRG Networks Meeting, University of Reading, UK	25-26 June, 2015
Delivered lecture on climate change and acted as Chief Guest of the workshop on “Advances in *in vitro* cell culture and functional applications”, Oxford College of Science, Bengaluru	6 July, 2015
Attended brainstorming session on “Climate resilient livestock production”, organized by NAAS, under the chairmanship of Dr Khub Singh, Chairman, JRDRF, NAAS, New Delhi	20 July, 2015
Attended 87th Foundation Day of ICAR and National Conference of KVKs, Patna	25-26 July, 2015
Attended On-site evaluation of Indo-German collaborative project on “Social-ecological systems in the Indian rural-urban interface, functions, scales and dynamics of transition – FOR 2432”, Germany	28 August - 2 September, 2015
Attended first meeting of the research advisory committee of the Environmental Management and Policy Research Institute, Bengaluru	15 September, 2015

Attended ICAR-ILRI workshop, NAAS, New Delhi	21-22 September, 2015
Attended Interactive Meeting of ICAR-DAHDF officials, chaired by Secretary, DAHDF and co-chaired by DG, ICAR, New Delhi	6 October, 2015
Attended meeting called by the Chief Secretary, Govt of Karnataka regarding State Level Executive Committee of National Livestock Mission	14 October, 2015
Attended workshop of Agro-climatic Zone-10 of southern plateau and hill region, ICAR-IIOR, under the chairmanship of DDG (AS), ICAR, Hyderabad	21 October, 2015
Convened the Meeting on 'Refinement of database model on feed and fodder availability in India, with the officials from Central Statistical Organization, ICAR-NDRI, ICAR-NIANP, NDDB and ICAR-IGFRI, ICAR-NIANP, Bengaluru	30 October, 2015
Attended Selection Committee meetings at ASRB for considering promotion of Sr Scientists to the post of Principal Scientist, New Delhi	4 November and 6 November, 2015
Attended 7th Kerala Veterinary Science Congress, organized by Indian Veterinary Association, Kerala, Trivandrum, KVASU, Pookode	14 November, 2015
Delivered special lecture on “Climate change and livestock production” in the 1-day workshop on “Climate resilient livestock management systems”, NDRI, Karnal	20 November, 2015
Attended 23rd International Grassland Congress, IGC-2015, organized by ICAR-IGFRI in association with Range Management Society of India; Chaired the technical session on “Emission of greenhouse gas from grasslands and mitigation actions” and delivered keynote address on “Forage conservation and its effect on feed digestion and absorption in livestock”, New Delhi	21-22 November, 2015
Attended Indo-German Nachkontact Association Seminar on “Enabling mechanisms for ensuring food and nutritional security”, organized by DAAD, Germany and CSIR-IICT, Hyderabad; Delivered guest lecture on “Livestock and climate change: inter-linking and measures to counter adverse impact”, Hyderabad	1 December, 2015
Attended XXXI Annual Convention of The Indian Society for Study of Animal Reproduction (ISSAR) on “Current challenges and opportunities in animal reproduction”, Veterinary College, Bengaluru	3 December, 2015
Attended the meeting of Directors of Animal Science Institutes, chaired by the DDG (AS), ICAR, New Delhi	21 December, 2015
Attended Interactive Meeting of Vice-Chancellors of SAUs and Directors of ICAR Institutes, New Delhi	23-24 January, 2016

The LRG Meeting 2015 at Centro Congress Lodi, Italy, 23-24 June, 2015

FNN Members at the meeting, University of Reading, UK, 25-26 June, 2015

Workshop/ Conference/ Seminar/ Symposium/ Krishi Mela/ Expo attended by the scientists/technical officers

Particulars	Participants
XXXI Annual Convention of The Indian Society for Study of Animal Reproduction (ISSAR) on "Current challenges and opportunities in animal reproduction", 3-5 December, 2015, Veterinary College, Bengaluru	A Arangasamy, A Mishra, BK Binsila, D Rajendran, IJ Reddy, J Ghosh, PSP Gupta, S Nandi, S Selvaraju
XXIV Annual Conference and National Symposium on 'Physiological approaches for development of climate resilient livestock farming' 21-22 January, 2016, CVSc, AAU, Guwahati	A Mishra, IJ Reddy, JP Ravindra, KS Roy, PSP Gupta
XXIII International Grasslands Congress (IGC2015), organized by the World Grassland Congress and ICAR-IGFRI, 19-23 November, 2015, New Delhi	AK Samanta, K Giridhar, PK Malik, S Manpal
XVI Biennial Animal Nutrition Conference on "Innovative approaches for animal feeding and nutritional research", 6-8 February, 2016, ICAR-NDRI, Karnal	AV Elangovan, KS Prasad, M Chandrasekharaiah, NM Soren, PK Malik, RS Umaya, S Manpal
Workshop on 'Use of Near Infrared Spectrometry' (NIRS), 30 April, 2015, ICAR-NIANP, Bengaluru	A Mishra, DT Pal, NKS Gowda, T Chandrappa, V Sejian, M Bagath
Workshop on "Transgenic livestock: technologies and applications", 19-20 February, 2016, organized by DBT, GOI and ICAR-NIVEDI, Bengaluru	J Ghosh, S Selvaraju
Workshop on "Protein expression and purification", 20-23 July, 2015, C-CAMP, Bengaluru	SC Roy
Workshop on "Livestock feeding and fodder development", 10 August, 2015, KVK, Davanagere	K Giridhar , NKS Gowda
Workshop on "Improved dairy farming", 1 January, 2016, Surya Milk society, Puttur, Dakshina Kannada	K Giridhar , NKS Gowda
Workshop on "Balanced feeding and improvement of green fodder production", 10 March, 2016, Dairy cooperative society, Balenhalli, Tumkur	K Giridhar, NKS Gowda
Workshop on 'Working group for preparing the action plan on climate change', 12 June, 2015, KVASU, Bengaluru	PK Malik
Workshop on 'Availability and judicious use of feed and fodder resources to meet the growing demand for milk production', jointly organized by NDDB, DADH and ICAR, 8 June, 2015, New Delhi	K Giridhar, G Ravikiran
Regional network for skills exchanges on dynamic adaptation of ruminant production systems to a changing environment- project workshop, 1-6 June, 2015, CIRAD, Re Union Island, France	PSP Gupta
UQ workshop on "Industry research engagement in India", 30 November, 2015, University of Queensland, St Lucia Campus, Australia	V Sejian
Sensitization workshop on "Mera Gaon- Mera Gaurav, 3 October, 2015, Directorate of extension, UAS, Bangalore	K Giridhar , NKS Gowda
Rashtriya Krishi Mela, 19-22 November, 2015, GKVK, Bengaluru	A Mishra, D Rajendran, G Letha Devi, K Giridhar, NKS Gowda, NM Soren, RS Umaya, T Chandrappa
Rabi campaign workshop, 23 January, 2016, KVK, Hirehalli, Tumkur	K Giridhar
National seminar on "Harmonizing biodiversity and climate change: challenges and opportunity, 17-19 April, 2015, ICAR-CIARI, Port Blair	V Sejian
National Conference on 'New approaches and concepts in microbial biotechnology', 29- 30 September, 2015, Maharani Science College, Bengaluru.	S Manpal
NAAS workshop on "State of Indian agriculture: soil", 21 August, 2015, New Delhi	K Giridhar
Meeting on 'Refinement of model for estimation of database on feed and fodder availability ', 30 October, 2015, ICAR-NIANP, Bangalore.	G Ravikiran, K Giridhar

Kharif campaign exhibition, 7 August, 2015, KVK, Hirehalli, Tumkur	G Letha Devi, K Giridhar, T Chandrappa
International workshop on “Managing the transition to sustainable economy: some insight from an evolutionary perspective”, 22–23 October, Griffith University, Brisbane, Australia	V Sejian
International conference on “Climate change and social-ecological-economical interface-building: modelling approach to exploring potential adaptation strategies for bio-resource conservation and livelihood development”, 20-21 May, 2015, ISEC, Bengaluru	G Letha Devi
Brain storming session on “Reproduction nutrition interaction” during Annual ISSAR Conference, 4 December, 2015, Veterinary College, Bengaluru	DT Pal , KS Roy
Brain storming session on ‘Climate resilient livestock production’, organized by National Academy of Agricultural Sciences, 20 July, 2015, NAAS complex, New Delhi	IJ Reddy, KS Roy, PK Malik, V Sejian
VIII GCRA International Conference on "Innovative digital applications for sustainable development", 5-7 January, 2016, UAS, Bengaluru	G Letha Devi
VII Kerala veterinary science congress 2015, 14-15 November 2015, Pookode, Kerala	S Selvaraju
VI World Congress on Biotechnology, 5-7 October, 2015, OMICS Group International, New Delhi	S Mondal
V Women’s Science Congress on “Science and technology for indigenous development of women In India”, Indian Science Congress 2016, 4-6 January, 2016, University of Mysuru, Karnataka	RS Umaya
IV Annual review workshop of the National Agricultural Science Fund, ICAR, 28-29 May, 2015, NAAS complex, New Delhi	A Dhali, AP Kolte, S Mondal
XIX ADNAT convention and International symposium on 'Microbiome in health and disease', 23-25 February, 2016, ICAR-NIANP, Bengal uru	A Arangasamy, A Dhali, A Mech, A Mishra, A Tulasi, AP Kolte, AV Elangovan, BH Venkataswamy, BK Binsila, S Senani, AK Samanta CG David, D Rajendran, DT Pal, G Letha Devi, G Maya, G Ravikiran, GSSR Krishnan, IJ Reddy, J Ghosh, JP Ravindra, K Giridhar, KS Prasad, KS Ramachandra, KS Roy, M Bagath, M Chandrasekharaiah, NKS Gowda, NM Soren, PK Malik, PSP Gupta, RS Umaya, S Jash, S Manpal, S Mondal, S Nandi, S Selvaraju, SBN Rao, SC Roy, T Chandrappa, V Kadakol, VB Awachat
XIV FAOBMB congress and 84th Annual Meeting of the SBCI on “Current excitements in biochemistry and molecular biology for agriculture and medicine, 27-30 November, 2015, Hyderabad	SC Roy
“Tropical Agriculture Conference 2015: meeting the productivity challenge in tropics” , 16-18 November, 2015, Brisbane, Australia	V Sejian
“International livestock conference and expo of ISAPM”, 28-31 January, 2016, Veterinary College, Hyderabad	A Mech, A Mishra, NM Soren, SBN Rao
“International conference on climate change and sustainability”, 21-23 December, 2015, Thakur College of Science and Commerce, Mumbai	S Mondal, S Nandi

"Global biotechnology summit", 5-6 February, 2016, DBT, Govt. of India, New Delhi	S Nandi
VII Indo-Global Summit and Expo on "Food and Beverages" 8-10 October, 2015, New Delhi	AK Samanta
Institutional Ethical Committee meeting of National Ayurveda Dietetics Research Institute, 14 March, 2016, Bengaluru	AK Samanta
Attended III Biennial Conference of Indian Academy of Veterinary Nutrition and Animal Health 4-5 November, 2015, CSK HPKV, Palampur	AK Samanta
DAHDF sponsored regional workshop on "Strengthening of small ruminant based livelihoods". 31 August, 2015, Bengaluru	NKS Gowda
44th Dairy Industry Conference, 18-21 February, 2016, ICAR-NDRI, Karnal	NKS Gowda
RAC meeting of ICAR-NRC on Yak, 1-2 June, 2015, Dirang	NKS Gowda
CPCSEA meeting at Ministry of Environment, Forests and Climate Change, 24 June, 2015, New Delhi	NKS Gowda
First Nodal Officer Workshop on Krishi Web Portal , 4-5 August, 2015, ICAR-IASRI, New Delhi	D Rajendran
Annual Review Meeting of Network project on VTCC, 18 November, 2015, NASC, New Delhi	A Thulasi, D Rajendran, M Chandrasekharaiah
EU-India Dialogue Seminar on "Food control, thematic dialogue sessions traceability and monitoring of residues and contaminants", 23-24 June, 2015, New Delhi	KS Prasad
International scientific workshop on "Safety assessment of GM foods" 14-15 October, 2015, New Delhi	KS Prasad
Regional Workshop on Nutrition and Feeding Strategies for Goats: Linking Climate Resilient Feeding and Poverty Alleviation" 1 June, 2015, ICAR - CIRG, Makhdoom	SBN Rao
International workshop on "Comprehensive Toxicology " organized by the Society of Toxicology, 27-31 July, 2015, Bengaluru	SBN Rao
Expenditure Review Committee meeting of ICAR -CRP on Biofortification under XII plan EFC, 10 December 2015, Krishi Bhawan, New Delhi	SBN Rao
III EURAXESS Science Slam India, 30 October, 2015, European Commission at Alliance Française, Bengaluru	S Jash
National workshop on "Molecular subtyping of microbes using pulsed field gel electrophoresis, 9 September, 2015, Veterinary College, Nagpur	AP Kolte
National Workshop on "Metagenomics and nutrigenomics for research and teaching in animal nutrition in India", 20 -21 November, 2015, ICAR -IVRI, Bareilly	AP Kolte
National workshop on "Diagnostic approaches for zoonotic diseases", 16 February, 2016, Veterinary College, Nagpur	AP Kolte

List of Workshop/ Training conducted for Stakeholders

Particulars	Date	Venue
Fertility camp and training on livestock feed and reproductive management	03 July, 2015	Belalkere, Davanagere
Interactive meeting with the farmers to improve milk fat percentage and fertility in dairy cows	21 July, 2015	Muthanallur, Bengaluru Rural

Workshop on livestock feeding and fodder development	10 August, 2015	KVK, Davanagere
Clean milk production	15 October, 2015	Ragihalli, Bengaluru Rural
New fodder varieties	10 December, 2015	Veerapura, Tumkur
Balanced feeding	10 December, 2015	Kadavigere, Tumkur
Silage making and urea treatment of dry fodder	14 December, 2015	BS Doddi, Bengaluru Rural
Livestock reproduction and health	15 December, 2015	Handenahalli, Bengaluru Rural
Fodder tree cultivation	15 December, 2015	Janappanahalli, Tumkur
Feeding and management of dairy cattle	16 December, 2015	Doddabommanahalli, Bengaluru Rural
Feeding of dairy animals	18 December, 2015	Muthanallar, Bengaluru Rural
Feeding of dairy cattle	18 December, 2015	Menasi, Bengaluru Rural
Livestock feed technology	23 December, 2015	Kuguru, Bengaluru Rural
Workshop on improved dairy farming	01 January, 2016	Puttur, Dakshina Kannada
Mineral mixture for sheep and goat	2 January, 2016	BS Doddi, Bengaluru Rural
Balance feeding of dairy cattle	5 January, 2016	Kuguru, Bengaluru Rural
Technology in livestock feeding	12 January, 2016	Bandaralahalli, Kolar
Reproductive problems	13 January, 2016	T Nagenahalli, Bengaluru Rural
Feed chart and ration balancing	18 January, 2016	Angalapura, Bengaluru Rural
Fish farming in villages	19 January, 2016	Katharenahalli, Tumkur
Rabi campaign workshop	23 January, 2016	KVK, Hirehalli, Tumkur
Improving milk quality	23 January, 2016	Handenahalli, Bengaluru Rural
Management of Reproductive problems	26 February, 2016	Ragihalli, Bengaluru Rural
Workshop on balanced feeding and improvement of green fodder production	10 March, 2016	Balenhalli, Tumkur
Feeding of dairy cattle	10 March, 2016	Balenahalli, Kolar

Overseas visits by scientists

Particulars	Participants
National Institute of Livestock and Grassland Science (NILGS), Tsukuba and Shinshu University, Nagano, Japan from 13 -16 December 2015 under the DST-JSPS (Indo-Japan) collaborative research project	AP Kolte , PK Malik

Allocation and Utilization of HRD fund

HRD fund allocation 2015-16 (lakh)			Actual Expenditure 2015-16 (lakh)	Utilization (%)
Plan	Non Plan	Total		
4.0	0.0	4.0	3.94	98.5

Other Activities

Research Advisory Committee

Members	Designation
Dr KM Bujarbaruah *Vice Chancellor, Assam Agricultural University, Jorhat*	Chairman
Dr Kusumakar Sharma *Former ADG (Edn), ICAR, New Delhi*	Member
Dr G Taru Sharma *Director CAFT and Head Physiology and Climatology Division, ICAR-IVRI, Izatnagar*	Member
Dr G Dinakar Raj *Director, Translational Research Platform for Veterinary Biologicals, TANUVAS, Chennai*	Member
Dr DVR Prakash Rao *Chairman and Managing Director, Foods and Feed Mills Pvt. Ltd., Chennai*	Member
Dr BS Prakash *ADG (AN and P), ICAR, New Delhi*	Member
Dr Raghavendra Bhatta *Director, ICAR-NIANP, Adugodi, Bengaluru*	Member
Dr KT Sampath *Former Director, ICAR -NIANP, Bengaluru*	Member
Shri Mahesh Patil *Kalaburagi, Karnataka*	Member
Dr JP Ravindra *I/c HOD APD, ICAR-NIANP, Bengaluru*	Member Secretary

The 21st meeting of the Research Advisory Committee (RAC) of the Institute was held on 2-3 February, 2016 under the Chairmanship of Dr KM Bujarbaruah, Vice Chancellor, Assam Agricultural University, Jorhat. Dr BS Prakash could not attend the meeting.

The Director, ICAR-NIANP welcomed the honourable Chairman and other members of the RAC for the meeting and briefed about the Institute activities and achievements for the appraisal of the new committee members. He also mentioned the constraints and financial hardship faced by the Institute and emphasized that the scientists should fetch more external research grants. He requested the RAC members to make an appeal to ICAR for creating a hostel facility, as many students are pursuing their master and doctoral research in the Institute currently.

The Chairman in his opening remarks thanked ICAR for reappointing him as the Chairman and complimented the Director for steering the developments related to facilities and research activities. He also mentioned that the technologies developed by the Institute should percolate to rural areas to help the small livestock farmers. Further, he suggested that ICAR-NIANP needs to carry out research activities on some of the important areas such as developing integrated nutrient management, designing vertical greenhouse based fodder production system, scaling up the feed use efficiency, using metagenomics approach for screening the high and low methane producing animals etc. He endorsed the Director's proposal for hostel facility for students and said that the RAC would recommend this to council. He expressed his happiness for the new RAC members and assured to extend his help wherever needed for the development of the Institute.

Following the brief presentations on the outcome of the completed research projects, progress of the ongoing projects and the new project proposals by the I/c Heads of the divisions/section, the Chairman and members expressed their satisfaction over the progress.

The major recommendations of the 21st RAC meeting are listed below.

- Considering advanced research approaches for developing nutritional modules for transition animals, precision feeding and water use efficiency.
- Initiating translational research programmes that are industry-oriented, keeping in view the viability of developed technologies for the benefit of farmers.
- Conducting a comparative study on supplementing ASMM and BIS mineral mixture in enhancing productivity.
- A relook into the current scenario in terms of area specific mineral deficiencies.
- Taking up research projects by identifying the real problems of livestock farmers at field level through interactive discussions with Animal Husbandry Department and KVKs.
- Conducting research on some of the important areas such as integrated nutrient management, vertical greenhouse based fodder production system, scaling up the feed use efficiency and metagenomics approach for screening the high and low methane producing animals.
- Creating hostel facility for students considering the fact that many students from ICAR-IVRI, ICAR-NDRI and other universities are currently pursuing research in this Institute and they need affordable accommodation.

Institute Research Committee

The 19th Annual Institute Research Committee (IRC) meeting was held under the Chairmanship of Dr Raghavendra Bhatta, Director, ICAR-NIANP on 1-2 May 2015. Dr G Dinkar Raj, Director, TRPVB, TANUVAS, Chennai was the invited external expert for the meeting. The Chairman emphasized that the scientists should be critical in undertaking basic and fundamental research and mentioned that the new projects must be fundamentally strong and comply with the Institute's mandate. He also mentioned that the scientists should make extra efforts to publish quality papers in the research journals with high impact factor. He asked the PME Cell to initiate process for systematic maintenance of all RPPs of individual scientists for proper monitoring and evaluation. During the meeting, the outcome of seven completed projects, progress of 12 ongoing Institute projects and 26 externally funded projects and the technical programmes of nine new project proposals were presented by the PIs and thoroughly reviewed. Dr G Dinkar Raj provided his valuable comments and suggestions to the scientists.

The midterm IRC meeting was held on 18 November, 2015, under the Chairmanship of the Director, ICAR-NIANP, Dr Raghavendra Bhatta. The progress of the 20 ongoing Institute research projects was reviewed during the meeting. The Chairman mentioned that every scientist should have at least one Institute project as PI. He also emphasized that the scientists should come out with some challenging deliverables like diagnostic kits, silage inoculums, technologies for improving reproductive efficiency, establishing rumen microbial diversity etc.

The IRC also facilitated the external evaluation of 12 completed projects for their technology validation and 24 ongoing projects for their progress on 16 November, 2015. Dr MJ Chandre Gowda, PS, ICAR-ATARI, Bengaluru, Dr GR Reddy, PS, IVRI (Reg. Stn), Bengaluru

and Dr G Glori Doss, Prof. and Head, Dept of Animal Nutrition, Veterinary College, Bengaluru were the external experts for the evaluation.

Institute Management Committee

The 34th and 35th Institute Management Committee (IMC) meetings were held respectively on 04 August, 2015 and 04 February, 2016 under the chairmanship of Dr Raghavendra Bhatta, Director, ICAR-NIANP, Bengaluru. During both the meetings, the Chairman briefed the various activities of the Institute including various research endeavours, and the action taken for the recommendations of the preceding meeting held was confirmed and agreed by the IMC. Different agenda items such as procurement of equipments, manpower, infrastructure development etc. were discussed in both the meetings and the proposals were recommended by the IMC.

Institute Management Committee

Members	Designation
Dr Raghavendra Bhatta Director, ICAR-NIANP, Bengaluru	Chairman
Dr Mukund Gajendragad Emeritus Scientist, ICAR-NIVEDI, Bengaluru	Member
Dr Sreenath Dixit Director-ATARI, Zone-VIII, Bengaluru	Member
Dr KP Ramesha Head ICAR-SRS-NDRI, Bengaluru	Member
Dr JP Ravindra I/c HOD APD, ICAR-NIANP, Bengaluru	Member
Assistant Director General (Animal Nutrition and Physiology) ICAR, New Delhi	Member
Shri Mahesh Patil Kalaburagi, Karnataka	Member
The Director Department of Animal Health and Veterinary Services, Govt of Karnataka, Bengaluru	Member
Dr Aswin Manubhai Thakkar Dean and Principal, College of Veterinary Science and Animal Husbandry, AAU, Anand	Member
Dr S Yathiraj Dean, College of Veterinary Science, KVAFSU, Bengaluru	Member
Dr KT Sampath Former Director, ICAR-NIANP, Bengaluru	Member
The Finance and Accounts Officer ICAR-NBAIR, Bengaluru	Member
Dr AV Elangovan I/c Assistant Finance and Accounts Officer, ICAR-NIANP, Bengaluru	Special Invitee
Shri Charles Ekka Senior Administrative Officer, ICAR-NIANP, Bengaluru	Member Secretary

In House Seminar

Date	Talk delivered	Speaker
28 Jul, 2015	EBSCO Agricultural database for full text Journals	S Venkatesha Kumar
13 Oct, 2015	Project file management under PME	DT Pal
27 Jan, 2016	KRISHI: Knowledge based resources information systems hub for innovations in agriculture	D Rajendran
27 Jan, 2016	Segregation plan for Laboratory Waste disposal	J Ghosh
15 Mar, 2016	Adaptation of feedlot cattle to chronic heat stress and modeling of green house gases in livestock farms	V Sejian

Linkage/Collaboration

Collaboration established with Japan (University of Shinshu and National Institute of Livestock and Grassland Science) and initiated DST-JSPS funded collaborative Indo-Japan project on "Methane mitigation using unexplored phyto sources in ruminants and their effect on rumen microbial diversity".

Collaboration established with Germany (University of Gottingen and Kassel University) to conduct joint research activities under the project on "Optimized use of feed resources for high lifetime productivity of dairy cows and consequences on enteric methane release".

Distinguished Visitors

Name of the Visitor	Date of visit
Dr Ellen Hoffman, Kassel University, Germany	25 Apr, 2015
Dr. Ben Sakker Kelly, First Secretary (Edn), Australian Embassy, New Delhi	3 Jun, 2015
Dr Ramesh Chand, Director, ICAR-NCAP, New Delhi	12 Jun, 2015
Dr SD Rai, former Assistant Director General (TC), ICAR, New Delhi	19 Jun, 2015
Dr HPS Makker, FAO, Rome	13 Aug, 2015
Dr Harry Clark, New Zealand Agricultural Greenhouse Gas Research, New Zealand	17 Aug, 2015
Dr Yutaka Uyeno, Shinshu University, Japan	18 Aug, 2015
Dr SS Honnappagol, Animal Husbandry Commissioner, Ministry of Agriculture and Farmers Welfare, Govt of India, New Delhi	20 Aug, 2015
Dr Satish Kumar, Chief Scientist and Group Leader, CSIR-CCMB, Hyderabad	7 Sep, 2015
Mrs Ritu Kakkar, IFS, Director General, Environmental Management and Policy Research Institute, Bengaluru	1 Oct, 2015
Dr AK Srivastava, Director and Vice-Chancellor, ICAR-NDRI, Karnal	20 Oct, 2015

Dr Ellen Hoffman, Kassel University, Germany

Dr. Ben Sakker Kelly, First Secretary (Edn)
Australian Embassy, New Delhi

Name of the Visitor	Date of visit
Shri AK Singh, Financial Adviser (DARE), ICAR, New Delhi	26 Oct, 2015
Shri Devendra Kumar, Director (Finance), ICAR, New Delhi	26 Oct, 2015
Dr Manmohan Singh, IAS, Department of Animal Husbandry and Fisheries, Govt of Andhra Pradesh and Vice-Chancellor, SVV University, Tirupati	5 Dec, 2015
Dr SK Agrawal, former Director, ICAR-CIRG, Makhdoom	5 Dec, 2015
Dr KML Pathak, Deputy Director General (AS), ICAR, New Delhi	11 Dec, 2015
Dr AK Rawat, Joint Director, Department of Biotechnology, Govt of India, New Delhi	7 Jan, 2016
Dr BN Tripathi, Director, ICAR-CIRB, Hisar	14 Jan, 2016
Dr Nagasundara Ramanan, Senior Lecturer, School of Engineering, Monash University, Malaysia	19 Feb, 2016
Prof. Bruce Whitelaw, Deputy Director and Head of Division of Developmental Biology, The Roslin Institute, University of Edinburgh, UK	21 Feb, 2016
Dr Athol Klieve, Group leader, Rumen Ecology, University of Queensland, Brisbane, Australia	22 Feb, 2016
Dr AS Ninawe, former Vice-Chancellor, MAFSU, Nagpur	9 Mar, 2016

Dr Yutaka Uyeno, Shinshu University, Japan

Dr Harry Clark, New Zealand

Dr SS Honnappagol, Animal Husbandry Commissioner, New Delhi

Dr AK Srivastava, Director and Vice-Chancellor ICAR-NDRI, Karnal

Dr Manmohan Singh, IAS, Govt of Andhra Pradesh

Dr Athol Klieve, University of Queensland, Australia

Students' Research

Name	Degree/ University/ Academic year	Dissertation title
PK Javvaji	PhD/ Jain University/ 2013-2016	Effect of cytokine supplementation on the development and quality of in vitro cultured sheep oocytes and embryos
FJ Rabinson	PhD/ Jain University/ 2013-2016	Effect of season on oocyte developmental competence in sheep
L Jose	PhD/ Jain University/ 2013-2016	Rumen metatranscriptome analysis to identify the genes involved in the deconstruction of plant cell wall polysaccharide
J Chikkerur	PhD/ Jain University/ 2013-2016	Isolation of microbes for enzymatic production of short chain oligosaccharides and its evaluation as prebiotic
S Roy	PhD/ Jain University/ 2015-2018	Effective biological production of D-tagatose using D-galactose and evaluation of its nutraceutical potentiality
D Shet	PhD/ Jain University/ 2012-2016	Production and evaluation of Microbial Phytase in the diet of layer chicken
A Sreeja	PhD/ Jain University/ 2012-2016	Purification and properties of fungal phytase and its evaluation in broiler chicken
BD Punith	PhD/ Jain University/ 2013-2016	Profiling liver transcriptome and defining the role of efflux transporter ATP7B during copper deficiency in sheep (*Ovis aries*)
VR Jithil	MVSc/ ICAR-IVRI/ 2014-2015	Comparative proteomic analysis of non pregnant and early pregnant buffaloes serum exosome fraction and urine
S Srividhya	PhD/ Jain University/ 2012-2015	Heterologous expression and characterization of buffalo pregnancy associated glycoprotein (PAG)
S Kannan	PhD/ Jain University/ 2013-2016	Supplementation of asymmetric cell kinetic inhibitor on long term maintenance of porcine mesenchymal stem cell culture
S Nazar	PhD/ Jain University/ 2012-2016	Angiogenesis pattern and its related gene expression in endometrial tissues during different stages estrous cycle in goats (*Capra hircus*).
L Somashekar	PhD/ Jain University/ 2012-2016	Assessing bull fertility based on seminal and sperm membrane proteins
G Dominic	PhD/ ICAR-NDRI/ 2013-2016	Evaluation of ayurvedic medicinal residues as non conventional feed resource in goat
V Thammaiah	PhD/ Jain University/ 2012-2015	The production of lignin peroxidase from white rot fungi and its role in delignification of crop residues
RG Rao	PhD/ Jain University/ 2013-2016	Biochemical characterization and mechanism of lignin degradation in crop residues using manganese peroxidase of Basidiomycete
TV Bhaskar	PhD/ ICAR-IVRI/ 2012-2015	Study on influence of boron on bone mineralization, immunity and histopathology in rats and sheep
R Soni	MVSc/ ICAR-NDRI/ 2015-2016	Studies on the effect of copper and selenium on granulosa cell estradiol synthesis in goats
L Baruah	PhD/ Jain University/ 2012-2015	Metagenomic analysis of rumen methanogen and fermentation dynamics using plant phenolics
A Mor	PhD/ Jain University/ 2013-2016	Expression profiling of developmentally important genes in sheep embryos during different embryonic stages
M Shilpa	MVSc/ KVAFSU/ 2014-2015	Identification of seminal RNAs as indicators of reproductive performance in bulls
S Parthipan	PhD/ Jain University/ 2012-2016	Identification of functional transcripts involved in fertility regulation of bull spermatozoa
TK Varun	MVSc/ ICAR-NDRI/ 2013-2015	Production of chitooligosaccharides from fishery waste, their characterization and evaluation as prebiotic
PS Swain	PhD/ ICAR-NDRI/ 2013-2016	Evaluation of nano zinc supplementation on growth, nutrient utilization and immunity in goats (*Capra hircus*)
BC Divyashree	PhD/ Jain University/ 2013-2016	Molecular characterization of some motility-associated proteins in buffalo (*Bubalus bubalis*) bull semen
M Rana	MVSc / ICAR-IVRI/ 2014-2015	Status of antioxidant defenses of epididymal fluid and sperm from caput to cauda in goat (*Capra hircus*)
S Shaji	Integrated MSc/ KVASU/2014-2015	Impact of heat and nutritional stress on adaptive capability of bucks
K Chaidanya	Integrated MSc/ KVASU/2014-2015	Impact of heat and nutritional stress on metabolic activity and rumen fermentation profile in bucks

Name	Degree/ University/ Academic year	Dissertation title
PA Abdul Niyas	Integrated MSc/ KVASU/2014-2015	Impact of heat and nutritional stress on the growth and reproductive performance of bucks
SK Tripathi	PhD/Jain University/ 2014-17	Metabolic stress on oocyte and uterine cell functions and its ameliorations: cellular and genomic approaches
SS Nongkhlaw	MSc/ ICAR-NDRI/ 201-2016	Effect of dietary selenium on mRNA expression of selenoproteins, antioxidant status and oxidative stability of muscle in lambs
VS Gurupriya	PhD/ ICAR-IVRI/ 2015- 2018	Molecular cloning and characterization of some of the proteases and protease inhibitors of buffalo bull semen
S Badami	PhD/ ICAR-IVRI/ 2015- 2017	Cryopreservation-associated biomolecular changes in buffalo semen
AA Sha	PhD/Jain University/ 2014-17	Metagenomic profiling of fecal microbial community in carnivorous leopards (*Panthera pardus*) and omnivorous sloth bears (*Melursus ursinus*)
N Jose	MVSc/ ICAR-IVRI/ 2014-2016	*In ovo* supplementation of zinc from different sources on post-hatch gut development, growth and immunity in broiler chicken
R Vikram	MVSc/ ICAR-IVRI/ 2014-2016	Evaluation of plasma and serum exosomes for differential proteome analysis and immuno detection of selected proteins in non-pregnant and early-pregnant buffalo urine

Others

Institute Technology Management Unit

The Institute Technology Management Unit maintains intellectual property (IP) portfolio and services provided by the Institute scientists and laboratories for sample analysis, contract research and commercialization of the technologies developed. The unit is guided by the office of ADG (IP&TM), New Delhi and ZTMC, ICAR-IVRI, Bareilly. The Institute Technology Management Committee is headed by the Director, ICAR-NIANP and members are drawn from different divisions/section with an external IP expert. The unit helps Institute scientists for patent search and application procedures. A total of 12 patent applications were filed by the Institute in recent past and as per the National Biodiversity Act, these proposals were sent to NBA for clearance. The sample analysis services available through this unit are feed proximate analysis, mineral estimation in animal feeds and biological samples, hormone estimation by RIA and microbiological and toxicological testing of feeds and feed components.

ASRB-ICAR Online Examination Centre

An online examination centre for Karnataka has been established at NIANP for ICAR NET/ARS Prelim exams conducted by Agricultural Scientists Recruitment Board, New Delhi. The centre is equipped with 100 terminals and two servers, 30KVA online UPS backup and a dedicated 8 mbps internet connectivity. The examination hall is under the surveillance of 7 IP-based high definition CCTV cameras. For smooth functioning, supervisor, assistant supervisor and technical personals were nominated to conduct the examinations during the reported period. Several mock tests were successfully conducted in the past and online examination (Net/ARS, 2014) was successfully conducted during 4-12 December, 2015.

ARIS Cell

Agricultural Research Information Systems (ARIS) Cell was set up in 1998 at ICAR-NIANP. The Cell looks after the maintenance of more than 200 computer systems and 100 printers. Most of the

Institute computers are provided with internet connectivity. The Institute has 100Mbps NKN connectivity in addition to the 8Mbps connectivity for ASRB-ICAR Online Examination Centre. The Cell has also introduced an online complaints portal for the earliest rectification of computer/network related problems. System Security service in all the systems is maintained with a server-based antivirus programme for centralized security monitoring. Dedicated software is used for monitoring internet usage with separate logging to support individual user. The Cell also maintains the Institute website, which is regularly updated with various Institute activities. Software such as Feed Base and web portals such as Feed Chart, Indian Livestock Feed Portal are also made available in the website.

Experimental Livestock Unit

The Experimental Livestock Unit (ELU) has the facilities for housing large and small ruminants, poultry bird and mouse/rat. The unit also possesses a small scale feed processing and storage facility. During the period 2015-2016, four buffaloes, 21 cattle, 51 sheep, 126 goats, 175 poultry birds and 90 rats were maintained for various experiments. During the reported period, animal experiments were conducted under 14 different research projects.

Fodder Production Unit

The Fodder Production Unit (FPU) of the Institute is ensuring round the year supply of green fodder to the ELU for maintaining animals. During the period 2015-2016, various crops like maize, jowar (variety: CoFS-29), rhodes grass, hybrid napier-bajra, guinea grass and para grass were cultivated. Demonstration plots with Co-5 variety of hybrid napier-bajra as well as mulberry were developed. The top feeds were regularly supplied from sesbania and gliricidia trees raised on the field bunds. Azolla cultivation was done in HDPE as well as silpaulin sheet ponds to supply the culture to several needy farmers. The seedlings of fodder trees like melia and sesbania, stem cuttings of gliricidia and hybrid napier-bajra, and the root slips of rhodes grass were supplied to several farmers. Silage was prepared from maize, sorghum, rhodes grass and guinea grass in the plastic bins. The fertility of two plots was improved by in situ green manuring with sunnhemp.

Library

The library of the Institute regularly procures various foreign and Indian research journals, books, magazines, newspapers and other publications to keep the scientists and technical staff abreast of the latest developments. In the period 2015-2016, the library also received 284 gratis publications from India as well as from International Institutions/ Organizations. A total of 3363 back volumes of Indian and foreign journals are available in the library.

The library facilities are also offered to the officials, students of veterinary colleges and universities, researchers and other ICAR Institute officials for

reference work. The library has developed and maintained a library web portal, which offers information on library history, books in stack, journal holdings (since 1995), online journals, database collection, current subscription of journals, scholarly publications (with abstracts), non-book materials etc. The portal is updated regularly. During the period 2015-2016, the library responded to 181 requests from the outside readers by sending articles of their interest by post/online under the Consortium for e-Resources in Agriculture (CeRA). The library has collected all the publications of the scientists since 1995 and launched an Institutional repository comprised of title, author, source and abstracts of the publications, which has been made available for retrieval and dissemination. The library also renders reprographic and lamination services to the staff, trainees, students and administration and account sections' personnel for official as well as personal purposes.

Official Language Implementation Cell

The Institute has a Raj Bhasha Anubhag for the implementation of official language policy of Government of India. The cell is guided by the Official Language Implementation Committee (OLIC) with the Director as its Chairman. During the period 2015-2016, quarterly meetings of OLIC were held regularly to review the progress made in official language implementation. The decisions taken in OLIC meetings were implemented. Minutes of these meetings were sent to ICAR headquarter for further monitoring. Four Hindi Workshops were held one in each quarter June, September, December and March. The workshops were organized to improve use of computers and software for carrying out routine office work in Hindi.

The Institute celebrated Hindi Fortnight from 14-30 September, 2015. Various competitions were organized during the fortnight. Under the auspices of Town Official Language Implementation Committee (TOLIC), ICAR-NIANP organized Solo Song Competition for the central government staff of Bengaluru. Dr Anjumoni Mech, Scientist, ICAR-NIANP secured consolation prize in Solo Song competition. Mr N Raghavan, PS to Director, ICAR-NIANP won 1st prize in Crossword and Dr K Giridhar and Dr S Senani jointly secured second prize for technical article in Hindi at the competition organized by TOLIC. ICAR-NIANP News Letter bagged 2nd Shield Award for the best News letter among the TOLIC Institutions. The Director and I/c Raj Bhasha Anubhag attended TOLIC meetings held on 27 July and 22 December, 2015 at NAL Bengaluru.

Agricultural Technology Information Centre

The Agricultural Technology Information Centre (ATIC) was established in November, 2011 based on the single window concept for providing information and advisory services on animal nutrition and physiology to the farmers and other visitors. ATIC advisory services facilitate information-based decision-making among the farmers by providing technology information in customized manner. ATIC provides real time information and advices on livestock farming, appropriate species, breeds and management practices etc., which are critical for the farmers. Information dissemination is carried out through personal interaction with visitors, interaction through telephone, information through reply of letters and participation in International /National Exhibitions/Farm fairs/ Farmer's meets etc.

Staff Welfare Club

The Staff Welfare Club (SWC) was actively involved in the various welfare activities of the staff during the period 2015-2016. The SWC bid farewell to Shri S Athimoolam (AO), Shri SR Nataraj (Assistant) and Shri KS Srikanta Sastry (SSS) on superannuation. The Club also organized farewell ceremony for Shri R Anbu, who left the Institute to join his new assignment. The SWC also organized and celebrated several events such as Independence Day, Republic Day, Ganesh Chaturthi, Ayudh Puja, New Year-2016, Makara Sankranti/Pongal and Kannada Rajyotsava". The 'Annual General Body Meeting' of the Club was held on 17 June, 2015. During the meeting, the members were appraised of the various activities and financial matter of the Club and new executive committee was elected to organize various activities of the club for the period of 2015-2017.

Games and Sports

The Institute has a Games and Sports Committee to promote healthy competitive spirit, feeling of fraternity and cooperation among the staff of the Institute. The Committee organized various sports events from 11-21 January, 2016 as part of the Republic Day celebrations. A number of events such as chess, carrom, rangoli, musical chair and badminton singles and doubles were organized for ladies. For men, volleyball, badminton, table tennis, carrom, chess and athletics events were organized. Some sports events are also organized on Independence Day and Republic Day for the children, which included 50m running race, spoon and lemon race, hit wicket and slow cycle race. A friendly T20 cricket match was also played on 26 January, 2016 between Director's eleven and SAO's eleven. The Institute was represented by a team of 10 members in the ICAR zonal sports held at CIFT, Cochin from 25-29 May, 2015. The team participated in carrom, chess, badminton and athletics events.

Complaints Committee/ Women's Cell

The Complaints Committee/Women's Cell of the Institute was functioned with Dr Manpal S, as chairperson, and Dr A Mech, Mrs Kalaivani and Dr S Senani (Male representative) as Members. Mrs U Nanaiah, Secretary, Mahila Dakshata Samiti, Bengaluru is the external member. The Cell meets regularly and looks into the welfare of the women employees, both permanent and contractual worker as well as the students working in the various laboratories of Institute.

Academic Cell

The Academic Cell facilitates MSc and PhD students persuing research work at the Institute for academics related matter. The Institute has signed MOU with several universities to offer research programs leading to MSc and PhD degree. The Institute collaborated with KVASU (Kerala), KVAFSU (Bengaluru), ICAR-IVRI (Izatnagar), ICAR-NDRI (Karnal) and Jain University (Bengaluru) for guiding MSc and PhD students in various disciplines. During the period 2015-2016, 25 PhD and 11 MSc students from Jain University, ICAR-IVRI, ICAR-NDRI, KVAFSU and KVASU pursued their research work at the Institute.

Human Resource and Development Cell

The Human Resource and Development (HRD) Cell is actively involved in facilitating various HRD activities related to training programmes and workshops on the practical aspects of animal nutrition, physiology and reproduction. During the period 2015-16, the Cell helped in organizing various training programmes and workshops for the Veterinary and Agricultural University faculties, ICAR Scientists, farmers and extension workers. The 'Attachment Training' under the orientation training programme in ARS for 3 months for the newly recruited ARS Scientists from different ICAR Institutes was also coordinated by the Cell.

Popular lecture on Genetically Engineering Livestock: How and Why

The Institute organized a popular lecture by the world renowned scientist Prof. Bruce Whitelaw, Deputy Director and Head of Division of Developmental Biology, The Roslin Institute, University of Edinburgh, UK on "Genetically Engineering Livestock: How and Why" for the benefit of young researchers and general public on 21 February, 2016. The event was organized in collaboration with the "Association for the Promotion of DNA Fingerprinting and other DNA Technologies (ADNAT), Hyderabad and Department of Biotechnology, Govt of India, New Delhi. In the lecture, he discussed how to apply this technology in the field of animal biotechnology, specifically novel ways to combat infectious disease in animals, evaluate strategies to enhance overall reproductive efficiency and explore opportunities to develop new treatments of disease through appropriate genetically engineered animal models. Prof. Bruce emphasized that genetically engineered animals are the solutions for many problems in animal and medical sciences. Nearly 100 participants attended the lecture.

Later, Prof. Bruce quoted in the official mediablog of the University of Edinburgh: "As part of ICAR, NIANP gives India a huge capability across the whole agricultural sector. This sector literally sustains India – and is also the basis for much of Indian life and culture. Agriculture in India is extremely diverse, representing a massive opportunity for genetic science. The University of Edinburgh is very strong in this discipline and it is not surprising that we have such strong relationships with our Indian colleagues across the agricultural and veterinary sciences".

International Symposium on Microbiome in Health and Disease (MICROHD2016)

The Institute, jointly with the "Association for the Promotion of DNA Fingerprinting and other DNA Technologies (ADNAT), Hyderabad" organized the "International Symposium on Microbiome in Health and Disease (MICROHD2016)" from 23-25 February, 2016. The symposium was attended by 170 delegates including 11 international speakers, nine national speakers and delegates from Roslin Institute, Edinburg University and Commonwealth Veterinary Association.

The symposium focussed on the importance of animal and human associated microbiome in maintaining animal and human health and performance. Dr Kalidas Shetty, Associate Vice President for International Partnerships and Collaborations and Professor (Plant Metabolism and Food Security), North Dakota State University, USA delivered the Keynote address. Dr Shetty described how fermented food systems with enriched diversity for beneficial microbiome can offer unique processing and nutritional solutions towards addressing global food and nutritional security challenges. Dr Srini V Kaveri, Director, Immunopathology and Therapeutic Immunointervention, Centre de Recherche des

Cordeliers, France emphasized the need of investigating the interaction of gut microbes and the host immune system to understand the molecular and cellular basis of the pathogenesis of autoimmune diseases and design novel therapeutic strategies. Other speakers of the symposium described the latest technological developments for characterizing microbiome, role of microbiome in performance and health with a special emphasis on rumen metabolism and possible strategies to manipulate microbiome for benefits. Scientific abstracts were also presented in the symposium by the students, academician and scientists, which emphasized the various aspects of microbiome research and applications in animal and human.

Celebration of Institute Foundation Day

The Institute celebrated its 20th Foundation Day on 5 December, 2015. Dr Manmohan Singh, IAS, Secretary to Govt of Andhra Pradesh, Department of Animal Husbandry and Fisheries and Vice-Chancellor, Sri Venkateswara Veterinary University, Tirupati was the Chief Guest of the event. The Director of the Institute made a presentation on this occasion, depicting the path of progress the Institute achieved in the last two decades of its existence. Speaking on the occasion, the Chief Guest lauded the contributions of the Institute and appreciated the Institute's efforts in coming out with novel approaches for assessing and improving nutrient availability, animal reproduction and productivity with different kinds of solutions in the wake of feed and fodder scarcity. The revised edition of laboratory manual entitled "Recent techniques in feed and fodder evaluation for assessing feed quality and safety" that was published by the Institute was released on the occasion.

Celebration of World Environment Day

The Institute celebrated World Environment Day on 5 June, 2015. Speaking on this occasion, the Director of the Institute emphasized the involvement of citizens in ensuring a clean and healthy environment for the welfare of the mankind and mentioned how as an individual we can contribute to that. He also encouraged the staff to follow the call given by our Honourable Prime Minister and maintain cleanliness in our premises and set a model in our surrounding areas. To mark this occasion, headed by the Director, a mass tree plantation programme was also undertaken by planting tree saplings in the Institute campus by all the staff.

Mera Gaon Mera Gaurav Programme

As directed by the ICAR, the Institute implemented the Mera Gaon Mera Gaurav (MGMG) programme for the benefit of farmers. Ten teams were made comprising of 3-4 scientists with one scientist as the team leader. Fifty villages within 100 km of radius of the Institute were adopted under this scheme. Each team periodically visited the villages to collect base line data, discuss with farmers about the existing problems and provide the suggestions/inputs for overcoming the problems related to animal husbandry. Capacity building and skill development in the form of workshops and demonstrations were conducted in the villages.

Swachh Bharat Abhiyan

In accordance with the instruction of Govt of India and ICAR, the Institute implemented and actively took part in the campaign Swachh Bharat Abhiyan, the cleanliness drive. Various initiatives were taken to maintain a clean and plastic free Institute campus. Periodic cleanliness drives were also arranged on 5 June and 9 October, 2015 to clean the campus under the campaign. During the cleanliness drives, entire staff of the Institute along with research scholars, contract workers, students and residents of the campus went round the Institute premises and joined hands for cleaning up the premises afresh.

Right to Information

During the period 2015-2016, a total of 14 RTI applications were received. Requisite information was provided for all the queries.

Personnel

List of Employees

Name	Designation
Dr Raghavendra Bhatta	Director
Animal Nutrition Division	
Dr KS Ramachandra	Principal Scientist, I/c HOD
Dr KS Prasad	Principal Scientist
Dr SBN Rao	Principal Scientist
Dr M Chandrasekharaiah	Principal Scientist
Dr AK Samanta	Principal Scientist
Dr S Senani	Principal Scientist
Dr S Anandan	Principal Scientist (on EOL)
Dr NKS Gowda	Principal Scientist
Dr DT Pal	Principal Scientist
Dr (Mrs) A Thulasi	Senior Scientist
Dr D Rajendran	Senior Scientist
Dr NM Soren	Senior Scientist
Dr AP Kolte	Scientist
Dr S Jash	Scientist
Dr M Bagath	Scientist
Animal Physiology Division	
Dr JP Ravindra	Principal Scientist, I/c HOD
Dr JR Ippala	Principal Scientist
Dr PSP Gupta	Principal Scientist
Dr S Mondal	Principal Scientist
Dr SC Roy	Principal Scientist
Dr S Nandi	Principal Scientist
Dr J Ghosh	Senior Scientist
Dr ICG David	Senior Scientist
Dr S Selvaraju	Senior Scientist
Dr A Arangasamy	Senior Scientist
Dr V Sejian	Senior Scientist
Dr A Mishra	Senior Scientist
Dr (Mrs) A Mech	Scientist
Dr G Krishnan	Scientist
Dr (Mrs) BK Binsila	Scientist
Bioenergetics and Environmental Sciences Division	
Dr (Mrs) M Sridhar	Principal Scientist, I/c HOD
Dr AV Elangovan	Principal Scientist
Dr KS Roy	Principal Scientist
Dr G Ravikiran	Senior Scientist
Dr (Mrs) RU Suganthi	Senior Scientist
Dr A Dhali	Senior Scientist
Dr PK Malik	Senior Scientist

Knowledge Management and Biostatistics Section	
Dr NKS Gowda	Principal Scientist, Section I/C
Dr K Giridhar	Principal Scientist
Dr G Letha Devi	Scientist
Shri T Chandrappa	Scientist
Technical Officers / Technicians	
Shri GSSR Krishnan	Assistant Chief Technical Officer, T-7/8 (Library)
Shri V Ramesh	Assistant Chief Technical Officer, T-7/8 (Maintenance)
Shri BH Venkataswamy	Assistant Chief Technical Officer, T-7/8 (FPU)
Dr VB Awachat	Senior Technical Officer, T-6 (ELU)
Shri VR Kadakol	Technical Assistant, T-3 (APD)
Shri DR Govinda	Technical Assistant, T-3 (Estate and Maintenance)
Mrs G Maya	Technical Assistant, T-3 (BEES)
Shri KM Kamalesh	Technical Assistant, T-3 (Maintenance)
Shri HS Narayana Rao	Senior Technician, T-2 (AND)
Shri. M Shivarama	Technician, T-1 (Maintenance)
Administration	
Shri Charles Ekka	SAO
Mrs R Kalaivani	AAO
Shri N Raghavan	PS
Shri SR Sreenivasa	Assistant
Shri R Suresh Babu	Assistant
Mrs JV Jyothi	Assistant
Shri A Neil Vincer	PA (on deputation)
Mrs B Geetha	UDC
Shri L Gowda	LDC
Shri A Murthy	LDC
Shri M Naveen Kumar	LDC
Accounts and Audit	
Mrs MP Mridula	Assistant
Mrs P Nagaraju	UDC
Supporting Staff	
Shri Chennamaraiah	SSS
Smt Ningamma	SSS
Smt Mahalakshmi	SSS
Shri K Narayana	SSS
Smt J Lakshmi	SSS

In Charges of Section/ Unit/ Cell

Section/ Unit/ Cell	In charge
Priority Setting, Monitoring and Evaluation Cell-I	Dr JP Ravindra
Priority Setting, Monitoring and Evaluation Cell-II	Dr KS Ramachandra
Institute Research Council	Dr DT Pal
Official Language Implementation Cell	Dr S Senani
RFD Cell	Dr SC Roy
HRD Nodal Officer	Dr AV Elangovan
Academic Cell	Dr KS Prasad
Library	Dr (Mrs) M Sridhar
Institute Technology Management Unit	Dr AP Kolte
Publication Cell	Dr A Dhali
Consultancy Processing Cell	Dr D Rajendran
Agricultural Technology Information Centre	Dr NKS Gowda
ARIS Cell	Dr M Bagath
Experimental Livestock Unit	Dr NKS Gowda
Fodder Production Unit	Dr K Giridhar
Women's Cell	Dr (Mrs) M Sridhar
Public Relation Officer	Dr AK Samanta
Public Information Officer	Dr SBN Rao
Citizen's Charter and Grievance Cell	Shri Charles Ekka
Institute Joint Staff Council	Shri DR Govinda
Radiological Safety Officer	Dr IJ Reddy
Member Secretary, Institute Animal Ethics Committee	Dr NKS Gowda

Recruitment/ Appointment/ Joining

Shri A Neil Vincer	Joined as Personal Assistant on deputation on 13-07-2015
Shri Charles Ekka	Joined as Sr. Administrative Officer on 07-12-2015
Dr G Krishnan	Joined as Scientist on 03-02-2016

Relieving

Shri Anbu R	Relieved from the post of Assistant on 31-03-2016 to join the post of Assistant Registrar at Indian Maritime University, Chennai

Retirement

Shri KS Srikanta Sastry	SSS (retired on superannuation on 31-05-2015)
Shri SR Nataraj	Assistant (retired on superannuation on 30-06-2015)
Shri S Athimoolam	AO (retired on superannuation on 31-10-2015)

Promotion

Name	Promoted to next higher post	With effect from
Dr ICG David, Senior Scientist	Senior Scientist (RGP 9000)	24-09-2012
Dr PK Malik, Senior Scientist	Senior Scientist (RGP 9000)	23-04-2015
Dr NM Soren, Senior Scientist	Senior Scientist (RGP 9000)	22-05-2015
Dr A Arangasamy, Senior Scientist	Senior Scientist (RGP 9000)	23-07-2015
Dr A Mishra, Senior Scientist	Senior Scientist (RGP 9000)	02-08-2015
Dr A Mech, Scientist	Scientist (RGP 7000)	01-01-2009

List of Research Projects

List of Research Projects

Programme 1: Deconstruction of Ligno-cellulosic Biomass for Improving Feed Utilization

Funding	Project Title	Duration	
		Start	End
DBT	Biomining of selected white rot fungi (WRF) for novel lignin peroxidase and manganese peroxidase for enhancing digestibility of crop residues	Mar, 2015	Mar, 2018

Programme 2: Biogeography of Gut Microbes in Animals

Funding	Project Title	Duration	
		Start	End
Institute	BGM 2.1: Molecular profiling of rumen acetogens at different developmental stages in sheep	Jul, 2012	Sep, 2015
Institute	BGM 2.2: Comparative rumen metagenomics of domestic ruminants	Apr, 2014	Mar, 2017
Institute	BGM 2.3: Development of 16s rDNA rumen microbes specific database	Apr, 2014	Mar, 2017
ICAR-Network	Veterinary Type Culture Collection - Rumen Microbes	Oct, 2009	Mar, 2017

Programme 3: Novel Approaches for Assessing and Improving Nutrient Bioavailability, Animal Reproduction and Productivity

Funding	Project Title	Duration	
		Start	End
Institute	APR 3.1: Precision feeding for enhancing milk production performance in cattle	Jun, 2012	Sep, 2015
Institute	APR 3.2: Amelioration of oxidative stress to prevent apoptosis of early sheep embryos	Apr, 2013	Sep, 2016
Institute	APR 3.3: Elucidating the endocrine and molecular mechanisms of feed restriction impacting somatotrophic axis in goats	Apr, 2013	Mar, 2016
Institute	APR 3.4: Elucidating role of boron on gene expression for calcium utilisation, immune response and anti-oxidant mechanism	Apr, 2014	Mar, 2017
Institute	APR 3.5: Utilization of Nano zinc and its impact on growth and reproduction in goats	May, 2014	Apr, 2017
Institute	APR 3.6: Modulation of Granulosa cell estradiol synthesis using copper and selenium	Jul, 2014	Jun, 2017
Institute	APR 3.7: Modulation of myostatin through different wavelengths of light and RNAi in broiler chicken	Jul, 2014	Mar, 2017
Institute	APR 3.8: Effect of dietary selenium on selenoprotein genes in lambs	Apr, 2014	Mar, 2017

Funding	Project Title	Duration	
		Start	End
Institute	APR 3.9: Nutritional conditioning for neonatal programming in broiler chicken: Gut development and Immunity	May, 2015	Mar, 2018
Institute	APR 3.10: Development of a novel semen extender for improved post-thaw motility of cryopreserved buffalo semen	Jul, 2015	Jun, 2019
Institute	APR 3.11: Development of ideal protocol for isolation and culture of ram spermatogonial stem cell	May, 2015	Apr, 2018
Institute	APR 3.12: Development of pregnancy associated glycoprotein (PAG) based immunoassay for buffaloes *(Bubalus bubalis)*	Apr, 2015	Mar, 2018
ICAR-AICRP	Nutritional and Physiological Interventions for Enhancing Reproductive Performance in Animals	Apr, 2014	Mar, 2017
ICAR-Outreach	Monitoring of Drug Residues and Environmental Pollutants	Nov, 2009	Mar, 2017
ICAR-NASF	Enhancing development competence of oocytes for better in vitro fertilizing ability	Apr, 2013	Mar, 2016
DBT	Bioconversion of agricultural wastes for production of nutraceuticals to improve the gut health in animals	Feb, 2013	Feb, 2016
DBT	Immobilized fungal phytase production and its dietary evaluation in broiler and layer chicken	Feb, 2012	Feb, 2016
DBT	Expression of copper chaperones and transporters in Copper-deficient sheep	Apr, 2013	Apr, 2016
DBT	Transcriptomic profiling of spermatozoa for selection of fertile bulls	Feb, 2012	Feb, 2016
DBT	Wnt signal mediated ovarian granulosa cell estrogen synthesis in ruminants	Nov, 2014	Nov, 2017
DBT	Transcript profiling and functional significance of molecular determinants of follicular and oocyte competence under metabolic stress	Sep, 2013	Sep, 2017
DBT	Organic zinc and copper supplementation on advancing puberty, spermatozoal transcription expression profile and fertility in goat	Nov, 2014	Nov, 2017

Programme 4: Feed Informatics, Feed Quality and Safety and Value Addition

Funding	Project Title	Duration	
		Start	End
Institute	FQS 4.1: Real Time estimation of livestock feed and fodder resources availability in India	Apr, 2015	Mar, 2018
Institute	FQS4.2: Development of a universal inoculum /s for production of quality silage	May, 2015	Apr, 2018
ICAR-CRP	Biofortification-evaluation of value addition cereals (vac) and cereal by products for animal feeding	Jan, 2015	Mar, 2017

Programme 5: Climate Change Impact on Livestock

Funding	Project Title	Duration	
		Start	End
Institute	3.15: Expression of HSP70 mRNA in visceral organs of broiler chickens under acute heat stress	Sep, 2011	Sep, 2015
Institute	CCL 5.1: Life cycle assessment of green house gas emission from dairy farms of Karnataka State	Mar, 2015	Mar, 2018
ICAR-Outreach	Estimation of methane emission under different feeding systems and development of mitigation strategies	Apr, 2008	Mar, 2017
ICAR-NASF	Deciphering the mechanism of aberrant maternal recognition of pregnancy (MRP) events in sheep and buffalo under heat and nutritional stress	Jan, 2011	Dec, 2015
DBT	Livestock methane reduction through immunization based approach	Aug, 2014	Aug, 2017
DST-JSPS	Methane mitigation using unexplored phyto-sources in ruminants and their effect on rumen microbial diversity	Aug, 2015	Aug, 2017

Programme 6: Technology Translation to Connect Discovery with Application

Funding	Project Title	Duration	
		Start	End
Institute	TTA 6.1: Socio-economic impact of area specific mineral mixture technology in Karnataka	May, 2015	Sep, 2016
ARChE_Net	Regional network for skills exchanges on dynamic adaptation of ruminant production systems to a changing environment	Apr, 2013	Jun, 2015
ICAR-Extramural	Need Assessment, Development and evaluation of web based Livestock Advisory and Information System	Mar, 2016	Mar, 2017

Annexure-I

RESULTS-FRAMEWORK DOCUMENT FOR ICAR-NATIONAL INSTITUTE OF ANIMAL NUTRITION AND PHYSIOLOGY (2014-2015)

RFD
Results-Framework Document
For
ICAR-National Institute of Animal Nutrition and Physiology
(2014-2015)

SECTION 1
Vision, Mission, Objectives and Functions

Vision

Productivity enhancement for profitable and sustainable livestock production

Mission

Improving production and reproductive efficiency in livestock through basic physiological and nutritional approaches

Objectives

1. Improving nutrient assimilation and physiological functions for enhancing livestock production and feed quality and safety assessment
2. Feeding and management strategies for reducing climate change impact on livestock
3. Human resource development

Functions

1. Conduct basic and fundamental research to address physiological and nutritional problems related to biophysical translation of nutrients for productive functions in livestock
2. Developing quality human resource in frontier areas of animal nutrition and physiology
3. Research translation to connect discovery with applications

SECTION 2

Inter se priorities among key objectives, success indicators and targets

Sl No	Objective(s)	Weight	Action(s)	Success Indicator(s)	Unit	Weight	Target /Criteria Value				
							Excellent	V. Good	Good	Fair	Poor
							100%	90%	80%	70%	60%
1.	Improving nutrient assimilation and physiological functions for enhancing livestock production and feed quality and safety assessment	50	Identification of factors / bio-molecules/tools influencing production and reproduction in livestock	Factors / bio-molecules/tools identified	Number	15	5	4	3	2	1
			Development of repository of anaerobic rumen microbes for better feed utilization	Anaerobic rumen microbes catalogued	Number	15	30	25	20	15	10
			Identification of microbes/microbial enzymes/rumen metabolic pathways for feed/fibre utilization	Microbes/microbial enzymes/rumen metabolic pathways for feed/fibre utilization identified	Number	10	5	4	3	2	1
			Screening of samples for quality and safety standards (heavy metals/pesticide residues/toxins)	Samples analyzed for heavy metals/pesticide residues/toxins	Number	10	54	45	36	27	18
2.	Feeding and management strategies for reducing climate change impact on livestock	20	Developing models for assessing climate change impact on feed resources in different states	States covered	Number	10	7	6	5	4	3
			Developing tools/techniques for ameliorating abiotic stress	Tools/techniques developed	Number	10	5	4	3	2	1
3.	Human resource development	10	Capacity building and skill development	Trainings / workshops conducted	Number	10	8	7	6	5	4
	Publication /Documentation	5	Publication of research articles in the journals having the NAAS rating of 6.0 and above	Research articles published	Number	3	24	20	16	12	8
			Timely publication of the Institute Annual Report (2013-2014)	Annual Report published	Date	2	30-06-14	02-07-14	04-07-14	07-07-14	09-07-14
	Fiscal resource management	2	Utilization of released plan fund	Plan fund utilized	%	2	98	96	94	92	90
	Efficient functioning of the RFD system	3	Timely submission of Draft RFD for 2014-2015 for Approval	On-time submission	Date	2	15-05-14	16-05-14	19-05-14	20-05-14	21-05-14
			Timely submission of RFD Results for 2013-2014	On-time submission	Date	1	01-05-14	02-05-14	05-05-14	06-05-14	07-05-14
	Enhanced Transparency /Improved Service delivery of Ministry/ Department	3	Rating from Independent Audit of implementation of Citizen's/Client's Charter (CCC)	Degree of implementation of commitments in CCC	%	2	100	95	90	85	80
			Independent audit of implementation of Grievance Redress Management (GRM) system	Degree of success in implementing GRM	%	1	100	95	90	85	80
	Administrative Reforms	7	Update organizational strategy to align with revised priorities	Date	Date	2	01-11-14	02-11-14	03-11-14	04-11-14	05-11-14
			Implementation of agreed milestones of approved mitigating strategies for reduction of potential risk of corruption (MSC)	% of implementation	%	1	100	90	80	70	60
			Implementation of agreed milestones for ISO 9001	% of implementation	%	2	100	95	90	85	80
			Implementation of milestones of approved Innovation Action Plans (IAPs)	% of implementation	%	2	100	90	80	70	60

SECTION 3
Trend Values of the Success Indicators

Sl No	Objective(s)	Action(s)	Success indicator(s)	Unit	Actual Value for FY 12-13	Actual Value for FY 13-14	Target Value for FY 14-15	Projected Value for FY 15-16	Projected Value for FY 16-17
1.	Improving nutrient assimilation and physiological functions for enhancing livestock production and feed quality and safety assessment	Identification of factors / bio-molecules/tools influencing production and reproduction in livestock	Factors / bio-molecules/tools identified	Number	NA*	4	4	4	4
		Development of repository of anaerobic rumen microbes for better feed utilization	Anaerobic rumen microbes catalogued	Number	NA	22	25	30	NA
		Identification of microbes/microbial enzymes/rumen metabolic pathways for feed/fibre utilization	Microbes/microbial enzymes /rumen metabolic pathways for feed/fibre utilization identified	Number	NA	NA	4	5	5
		Screening of samples for quality and safety standards (heavy metals/pesticide residues/toxins)	Samples analyzed for heavy metals/ pesticide residues/toxins	Number	NA	NA	45	50	54
2.	Feeding and management strategies for reducing climate change impact on livestock	Developing models for assessing climate change impact on feed resources in different states	States covered	Number	4	5	6	NA	NA
		Developing tools/techniques for ameliorating abiotic stress	Tools/techniques developed	Number	NA	NA	4	4	4
3.	Human resource development	Capacity building and skill development	Trainings / workshops conducted	Number	7	7	7	7	7
	Publication /Documentation	Publication of research articles in the journals having the NAAS rating of 6.0 and above	Research articles published	Number	NA	NA	20	20	20
		Timely publication of the Institute Annual Report (2013-2014)	Annual Report published	Date	NA	NA	02-07-14	NA	NA
	Fiscal resource management	Utilization of released plan fund	Plan fund utilized	%	NA	NA	96	NA	NA
	Efficient functioning of the RFD system	Timely submission of Draft RFD for 2014-2015 for Approval	On-time submission	Date	NA	NA	16-05-14	NA	NA
		Timely submission of RFD Results for 2013-2014	On-time submission	Date	NA	NA	02-05-14	NA	NA
	Enhanced Transparency /Improved Service delivery of Ministry/ Department	Rating from Independent Audit of implementation of Citizen's/Client's Charter (CCC)	Degree of implementation of commitments in CCC	%	NA	NA	95	NA	NA
		Independent audit of implementation of Grievance Redress Management (GRM) system	Degree of success in implementing GRM	%	NA	NA	95	NA	NA
	Administrative Reforms	Update organizational strategy to align with revised priorities	Date	Date	NA	NA	02-11-14	NA	NA
		Implementation of agreed milestones of approved mitigating strategies for reduction of potential risk of corruption (MSC)	% of implementation	%	NA	NA	90	NA	NA
		Implementation of agreed milestones for ISO 9001	% of implementation	%	NA	NA	95	NA	NA
		Implementation of milestones of approved Innovation Action Plans (IAPs)	% of implementation	%	NA	NA	90	NA	NA

* ***NA: Not applicable***. *The target values for the year 2014-2015 have been given for respective success indicators of the objectives. For some success indicators the actual and/or projected values have not been given as either these activities were not initiated during those years or some of the activities have ended.*

SECTION 4

Description and Definition of Success Indicators and Proposed Measurement Methodology

Objective 1. Improving nutrient assimilation and physiological functions for enhancing livestock production and feed quality and safety assessment

Acute shortage of quality inputs is affecting production and reproduction in livestock and poultry. There is a need to understand basic mechanism of the nutrient uptake and different physiological functions so as to optimize production and reproduction. In this context, factors that influence nutrient bioavailability and utilization, production and reproductive processes need to be explored in livestock.

Efforts will be made to identify the factors/bio-molecules influencing production and reproduction in livestock. Repository of anaerobic rumen microbes for better feed utilization will be developed. These will be measured by the numbers of factors/bio-molecules identified and anaerobic rumen microbes characterized/catalogued.

Objective 2. Feeding and management strategies for reducing climate change impact on livestock

Climate change can strongly affect the availability of feed resources in different regions of the country. Hence, there is a need to develop methods to assess the availability of feeds, which in turn will help in taking strategic measures to address the problem of feed deficiency. Enteric methane emission from livestock is one of the major problems for global warming and mitigation strategies need to be worked out by understanding the methane production potential of various feeds and cataloguing them.

Models and tools will be developed for assessing climate change impact on feed resources in different states of the country as well as on livestock production. Cataloging of the feed resources based on their methane production potential will be done. These will be measured by the number of models developed for different states and feed resources catalogued based on methane production potential.

Objective 3. Human resource development

Due to significant growth of animal husbandry sector in the country, there is increased demand for trained human resources to address issues related to the animal husbandry. To maintain this demand, development of quality human resource is important which could be achieved by providing training and developing skills. As feeding and management of animals accounts for about 60-70% of the total cost of livestock production, providing training and skill development will help the various stake holders including farmers to adopt to recent techniques for improving the production and get better economic returns.

Various trainings/workshops in frontier areas of animal nutrition and physiology will be conducted. This will be measured by the number of trainings/workshops conducted and manpower trained.

Objective 4. Efficient functioning of RFD System

For the efficient functioning of the Institute towards the agreed objectives, policies, programs and projects, and the subsequent evaluation of the institute performances it is important to implement the efficient functioning of RFD system.

The Draft RFD (2014-2015) will be submitted to the Council for approval within the stipulated time period so as the results for RFD for preceding financial year. Its functioning will be measured by the date of submission of the documents to the council.

Objective 5. Administrative Reforms

The efficient functioning of an organization depends on timely and need-based reforms of its administrative policies. It is important for an organization to introduce new thoughts and suitable modifications of the existing procedures based on the current demand for making the system more efficient.

The ISO 9001 will be implemented as per the approved action plan. An action plan for introducing innovation into the institute functioning will be prepared. The implementation of ISO 9001 action plan will be monitored with due auditing and certification of the procedures. Similarly, the innovation action plan of the Institute will be measured by awarding the winners of innovation.

Objective 6. Improving internal efficiency / responsiveness/ service delivery of Ministry / Department

It is important for a government organization to be transparent, accountable and citizen friendly to ensure citizen centric administration. To ensure the service delivery excellence it is important for an organization to clearly define and communicate service standards and take necessary steps to achieve these in time-bound manner.

Independent audit of implementation of Citizen's Charter and grievance redressal system will be conducted to measure their performances.

SECTION 5
Specific Performance Requirements from other Departments

1. Efficiency of cataloguing of anaerobic rumen microbes will depend on the collaborators (National Institutes/ SAUs) for timely submission of rumen bacteria.

2. The number of trainings/ workshops that will be conducted will depend of the nominations of trainees from their parent departments (SAUs/Director of extension/ DAHDF, GOI).

SECTION 6
Outcome/impact of activities of Department/Ministry

Sl No	Outcome/Impact	Jointly responsible for influencing this outcome/impact with the following departments/ ministry (ies)	Success indicator (s)	Unit	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017
1	Improved productive /reproductive efficiency of livestock	Livestock farmers, state agricultural universities, milk federations / feed industries	Animals displayed estrous/ conceived by supplementing area specific mineral mixture (ASMM)	Percentage	35	40	45	50	55
			Increase in egg production by using red spectrum light	Percentage	2.0	2.25	2.5	3.0	3.0
			Reduction in the cost of feeding of dry fodder by replacing paddy straw with areca sheath	Percentage	35	40	45	50	50
2	Development of quality human resources	State Agricultural Universities, /Animal Husbandry departments	Persons trained	Number	150	200	200	200	200

Performance Evaluation Report (2014-2015)

Sl No	Objective(s)	Weight (%)	Action(s)	Success Indicator(s)	Unit	Weight	Target / Criteria Value					Achievements	Performance	
							Excellent	Very Good	Good	Fair	Poor		Raw Score	Weighted Score
							100%	90%	80%	70%	60%			
1	Improving nutrient assimilation and physiological functions for enhancing livestock production and feed quality and safety assessment	50	Identification of factors / bio-molecules/tools influencing production and reproduction in livestock	Factors / bio-molecules/tools identified	Number	15	5	4	3	2	1	5	100	15
			Development of repository of anaerobic rumen microbes for better feed utilization	Anaerobic rumen microbes catalogued	Number	15	30	25	20	15	10	30	100	15
			Identification of microbes/microbial enzymes /rumen metabolic pathways for feed/fibre utilization	microbes/microbial enzymes/rumen metabolic pathways for feed/fibre utilization identified	Number	10	5	4	3	2	1	5	100	10
			Screening of samples for quality and safety standards (heavy metals/pesticide residues/toxins)	Samples analyzed for heavy metals/pesticide residues/toxins	Number	10	54	45	36	27	18	55	100	10
2	Feeding and management strategies for reducing climate change impact on livestock	20	Developing models for assessing climate change impact on feed resources in different states	States covered	Number	10	7	6	5	4	3	7	100	10
			Developing tools/techniques for ameliorating abiotic stress	Tools/techniques developed	Number	10	5	4	3	2	1	5	100	10
3	Human resource development	10	Capacity building and skill development	Trainings / workshops conducted	Number	10	8	7	6	5	4	12	100	10

Sl No	Objective(s)	Weight (%)	Action(s)	Success Indicator(s)	Unit	Weight	Target / Criteria Value					Achievements	Performance	
							Excellent	Very Good	Good	Fair	Poor		Raw Score	Weighted Score
							100%	90%	80%	70%	60%			
4	Publication/ Documentation	5	Publication of research articles in the journals having the NAAS rating of 6.0 and above	Research articles published	Number	3	24	20	16	12	8	24	100	3
			Timely publication of the Institute Annual Report (2013-2014)	Annual Report published	Date	2	30-06-14	02-07-14	04-07-14	07-07-14	09-07-14	30-07-14	100	2
5	Fiscal resource management	2	Utilization of released plan fund	Plan fund utilized	%	2	98	96	94	92	90	97.83	99.82	1.99
6	Efficient functioning of RFD System	3	Timely submission of Draft RFD for 2014-2015 for Approval	On-time submission	Date	2	15-05-14	16-05-14	19-05-14	20-05-14	21-05-14	26-05-14	100	2
			Timely submission of Results for 2013-2014	On-time submission	Date	1	01-05-14	02-05-14	05-05-14	06-05 -14	07-05-14	10-04-14	100	1
7	Enhanced Transparency /Improved Service delivery of Ministry/ Department	3	Rating from Independent Audit of implementation of Citizen's/Client's Charter (CCC)	Degree of implementation of commitments in CCC	%	2	100	95	90	85	80	99	99	1.98
			Independent audit of implementation of Grievance Redress Management (GRM) system	Degree of success in implementing GRM	%	1	100	95	90	85	80	100	100	1

Sl No	Objective(s)	Weight (%)	Action(s)	Success Indicator(s)	Unit	Weight	Target / Criteria Value					Achievements	Performance	
							Excellent	Very Good	Good	Fair	Poor		Raw Score	Weighted Score
							100%	90%	80%	70%	60%			
8	Administrative reforms	7	Update organizational strategy to align with revised priorities	Date	Date	2	01-11-14	02-11-14	03-11-14	04-11-14	05-11-14	09-10-14	100	2
			Implementation of agreed milestones of approved mitigating strategies for reduction of potential risk of corruption(MSC)	% of implementation	%	1	100	90	80	70	60	90	90	0.9
			Implementation of agreed milestones for ISO 9001	% of implementation	%	2	100	95	90	85	80	100	100	2
			Implementation of milestones of approved Innovation Action Plans (IAPs)	% of implementation	%	2	100	90	80	70	60	100	100	2

Total Composite Score = 99.87

ICAR Rating: Excellent

Green Animal Agriculture

Save Our Planet

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